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COMPOUND LOCOMOTIVES WITH SUPERHEATERS.

In the application of the superheating system to locomotives, this system is usually considered as in competition with the compounding system, and is considered by some engineers to be superior to the latter. The combination of both these systems is not usual, but we illustrate herewith a compound locomotive fitted with a superheater. The engine is a two-cylinder compound consolidation freight locomotive with Cole superheater and was built at the Schenectady shops of the American Locomotive Co. for the Minneapolis, St. Paul & Sault Ste. Marie Ry. The designs were made under the supervision of Mr. T. A. Foque, Mechanical Superintendent of that road.

tive described above has also been put in service for comparison with the regular two-cylinder compound mogul engines on a division in North Dakota where the water supply is alkaline. The tube arrangement of the superheater, however, is different from that of the consolidation engine; instead of 40 tubes 3½ ins. diameter there are 20 tubes 5 ins. diameter, and in each of these is a group of four small tubes. The mogul engine with superheater weighs about two tons more than the similar engines without superheaters.

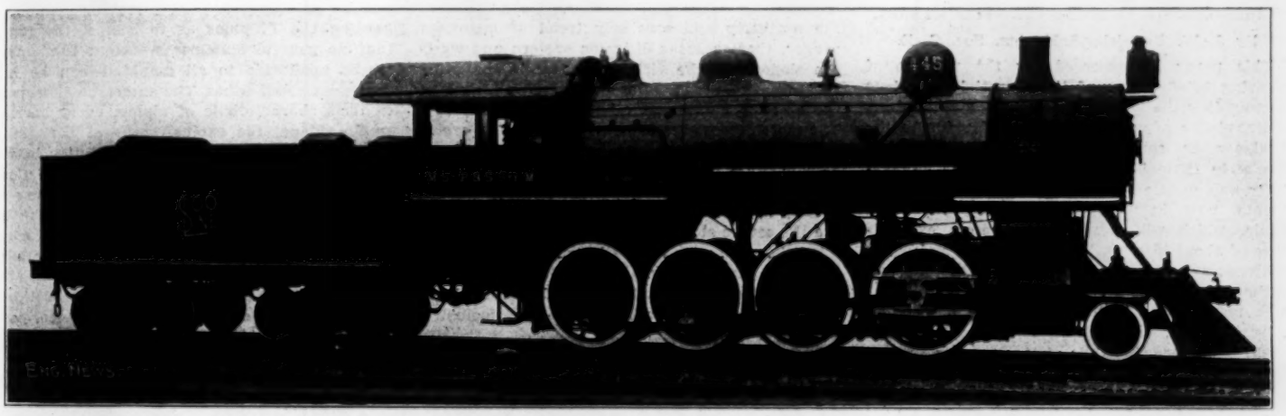
An extended discussion on the application of the superheating system to locomotives was published in our issue of June 22, and in connection with the use of superheated steam on compound locomotives, we quote the following paragraphs from the paper presented at the Washington meeting of the International Railway Congress by Mr. J. E. Muhlfeld, General Superintendent of Motive Power of the Baltimore & Ohio Ry.:

The economy shown by superheating is so well defined that there is now no question of its effective and substantial saving. Superheated steam locomotives whether compound or simple, show about the same percentage of economy over an ordinary simple locomotive. A number of tests have been made with simple types of locomotives using superheated steam, in comparison with similar types of compounds, but as yet no definite conclusions (more particularly with respect to the successive superheating before the steam enters the cylinders of compound locomotives) have been arrived at. It is estimated that the use of superheated steam in connection with compound engines will give about the same results by reduced loss in cylinder condensation, as the triple expansion of steam without the superheating.

The fact that the compound can be replaced by the simple locomotive, with increase of power and lower pressure in the boiler, is an advantage, even if no economy in fuel is obtained. As superheated steam applied to locomotives gives a higher thermo-dynamic efficiency than that realized from compound locomotives using saturated steam, it will enable the possibility of obtaining the advantages of compounding, without the introduction of the objectionable features. The possibility for increasing the capacity and economy of present locomotives by superheating is of even greater importance, as boilers which may be deficient in design or capacity can be much improved in effectiveness, and superheaters can be applied without altering the general design or construction of the boiler or mechanism.

In order to profit by the increased power resulting from superheating, the size of the cylinder should be increased to an extent proportional to the amount by which the consumption of heat by the ordinary locomotive exceeds that of the locomotive using superheated steam, when both do the same amount of work. Also, on account of the volume of superheated steam being greater than an equal weight of saturated steam for equal work, a longer cut-off may result from expansion below the point of saturation and some of the advantages of superheating will be lost. Therefore, on new locomotives fitted with superheaters, it would seem advisable to slightly increase the cylinder volume to insure the greatest benefit.

The dimensions of the compound consolidation engine of the Minneapolis, St. Paul & Sault Ste. Marie Ry., are given below in our standard form:



COMPOUND CONSOLIDATION FREIGHT LOCOMOTIVE WITH SUPERHEATER; MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE RY.

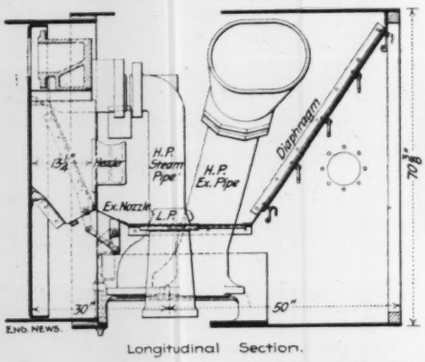
The engine is one of a number of new consolidation freight engines which are all two-cylinder compounds, but it is the only one equipped with a superheater, and is of an experimental character. The first illustration is a view of the engine and Figs. 2 and 3 show the arrangement of the superheater tubes. The boiler has tubes 15 ft. 9 ins. long, and 40 of these (A) are 3½ ins. diameter. In each of these large tubes (and close to the upper side of the tube) is placed a 2-in. tube (B) closed at the firebox end and extending beyond the smokebox tube plate to the rear compartment of a header or chamber in the smokebox, and 13¼ ins. from the tube plate. Inside of each 2-in. tube is a 1.3-in. tube (C) open at the rear or firebox end and extending through the partition of the header into its front compartment. The flame and gases pass through the largest tube. The saturated steam from the boiler enters the front compartments of the header and passes back through the small tube, C, returning through the 2-in. tube to the rear compartment of the header, whence it passes to the high-pressure cylinder.

This railway has had extensive and satisfactory experience with two-cylinder compound engines in freight service, and a mogul freight locomotive having the same combination of compounding and superheating as in the consolidation locomo-

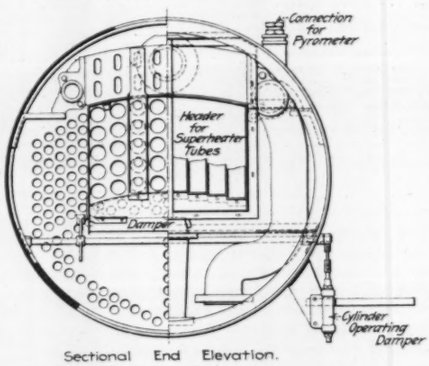
COMPOUND CONSOLIDATION FREIGHT LOCOMOTIVE WITH SUPERHEATER; MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE RY.

Running Gear:	
Driving wheels (8), diameter	5 ft. 3 ins.
Truck wheels (2), diameter	2 ft. 9 ins.
Tender wheels (8), diameter	2 ft. 9 ins.
Driving wheel centers	Cast steel
Engine truck	Swing bolster
Journals, driving axles	9½ × 12 ins. and 9 × 12 ins.
Wheelbase; Driving	17 ft. 0 ins.
Total engine	25 ft. 11 ins.
Engine and tender	55 ft. 10½ ins.
Engine truck-pin to c. of 1st driving axle	8 ft. 11 ins.
Wheels having blind tires	None
Weight in Working Order:	
On driving wheels	172,000 lbs.
Engine, total	201,500 lbs.
Engine and tender	318,400 lbs.
Cylinders (2)	23 × 34 and 35 × 34 ins.
Ratio of area of h.p. to l.p. piston	1 to 2.315
Form of crosshead and guides	Four-bar; alligator
Connecting rod, length between centers	11 ft. 6 ins.
Valve Gear; Type	Stephenson link
Eccentrics, throw	5¼ ins.
Valves	h.p., slide; l.p., piston
Valves, steam lap	h.p., 1¼ ins.; l.p., 1 in.
Valves, exhaust clearance	¾-in.
Valves, maximum travel	6 ins.
Valves, lead (full forward and backward gear)	None
Boiler: Type	Extended wagon top
Barrel, diam. outside first ring	5 ft. 7⅝ ins.
Dome, diam.	2 ft. 8 ins.
Barrel plates	11/16 and 5/8-in.
Smokebox tube plate	½-in.
Height from rail to center line	9 ft. 7 ins.
Length of smokebox	6 ft. 8 ins.
Spark arresting device	Diaphragm and netting
Working steam pressure	210 lbs.

Firebox; Type	Wide
Length inside	8 ft. 0⅛ in.; width inside 5 ft. 10¼ ins.
Thickness, side, back and crown plates	⅜-in.
Thickness, tube plate	½-in.
Crown stays	Radial; and crown bars at front end
Water spaces, width at front, 5 ins.; at back & sides,	4½
Tubes; Iron; No.	264
Thickness	No. 11 and No. 8, W. G.
Diameter, outside (224) 2 ins.; (40)	3½ ins.
Length over tube plates	15 ft. 9 ins.
Heating Surface and Grate Area:	
Heating surface, tubes	2,407.5 sq. ft.
Heating surface, firebox	158.0 sq. ft.
Heating surface, total	2,565.5 sq. ft.
Superheating surface	261.0 sq. ft.
Grate area	46.8 sq. ft.
Ratio of total heating surface to grate area	1 to 48.4



Longitudinal Section.



Sectional End Elevation.

FIG. 2. SMOKEBOX AND SUPERHEATER.

Exhaust nozzle, single, diameter	5¼, 5¼, 5¼ ins.
Exhaust nozzle, distance below center line boiler	4¼ ins.
Smokestack, diameter at top 18 ins.; at base	16 ins.
Smokestack, height of top above rail	14 ft. 9⁹⁄₁₆ ins.
Capacity of tender tank	6,000 gallons
Capacity of coal space	10 tons
Total tractive force with effective pressure equal to 85% of boiler pressure	37,300 lbs.

LABOR CONDITIONS IN THE PHILIPPINE ISLANDS.

By J. W. Beardsley,* M. Am. Soc. C. E.

This paper is presented for the purpose of showing briefly some of the essential conditions surrounding the labor problem in the Philippines, a knowledge of which would be of value to the engineer or contractor contemplating public works in those islands. The subject is particularly appropriate in view of the harbor improvements now in progress at Manila, Cebu, and Iloilo, which will together involve an expenditure of about $5,000,000; the new sewer and water systems, and the railroad projects, involving an estimated cost of about $4,000,000, and $30,000,000, respectively, both of which are now under advertisement, and other more or less extended and much-needed public improvements which must be prosecuted in the near future.

That portion of the paper relating to the characteristics of the Filipino is written with special reference to that class of the Filipino people from which are drawn the unskilled laborers, without whose assistance the development of agriculture and the prosecution of public improvements would be impossible. It is to be noted that it is that class with which the American people are especially concerned in their repeated enunciation of the governmental policy of the "Philippines for the Filipinos," a "square deal," and "equal rights for all."

The Philippine Islands lie approximately between the meridians 117° and 127° E. Long., and between the parallels 5° and 21° N. Lat. They are, therefore, entirely within the tropics. The number of islands is given as 3,141, and they are mostly of volcanic origin, fringed with extensive coral reefs. The total land area is 115,026 square miles, an area equivalent to 3.8% of the area of the main part of the United States, while the lengths of the coast lines of the two countries, measured by the same general rules, are approximately equal.

The two larger islands, Luzon and Mindanao, containing 40,969 and 36,292 square miles, respectively, comprise 67% of the total area, Samar has an area of 5,031 square miles, and 8 of the larger remaining islands vary in size from about 1,000 to 5,000 square miles. These eleven islands comprise a total area of 106,823 square miles, or 93% of the area of the entire islands; 2,775 of the remaining islands, representing 88% of the total number, are each less than one square mile in area; of that number 2,046, or 65% of the total number, have each an area of less than one-tenth of a square mile.

In general, the larger islands are elongated, the major axis extending northerly and southerly and the interior portions are mountainous and sparsely inhabited, while the fertile coastal plains are densely populated.

The Manila Observatory, established in 1865, is to-day one of the most complete institutions of its kind in the world. Some sixty sub-stations are now scattered throughout the islands. The prevailing winds from June to October are from the southwest, and from November to May north, northeast, and east. There are, in general, two seasons—the rainy and the dry. On account of the northerly and southerly trend of mountain ranges, these seasons differ on eastern and western slopes. In the vicinity of Manila the rainy season extends from June to December, inclusive; the extreme months may be either rainy or dry. The most destructive storms, the typhoons, are of relatively frequent occurrence during the months of July, August and September. They are generally predicted several hours in advance and are usually no more serious to shipping interests than are the severe storms of the Atlantic Coast.

Provisions against the destructive effects of frost are unnecessary.

The maximum velocity of wind recorded at Manila during the years 1885 to 1898, inclusive, was between 7 and 8 a. m., on Sept. 30, 1890, when a velocity of 100 kilometers (62 miles) per hour was recorded; during this hour, however, puffs or squalls occurred which measured one and one-half times this velocity, or about one hundred miles per hour. These maximum velocities were recorded during the passing of a typhoon north of Manila, and generally occur during the month of September.

Tables I. to III., from the Census Report, 1903, show the maximum velocities recorded in Manila during the month of September, from 1885 to 1898, inclusive, and also of January for the period, the latter being the lowest average maximum velocities.

There are in the Philippines two main classes of people, the "gente ilustrado," or the upper class, and the "gente baja," "tao," or the lower class. The middle class, that predominating and important class in the affairs of the United States, is practically lacking. The degree of literacy may be taken as a fair criterion by which to distinguish these two classes. The following statement from the Census Report for 1903, Vol. II., p. 78, applies to those who were able "to read and write in any language—English, Spanish, or a Malay tongue . . ."

Those who were able to read but not write numbered 1,208,845, which was 24.3%, or a little less than one-quarter of all the inhabitants 10 years of age and over. Those able to both read and write numbered 1,002,585, and constituted 20.2%, or about one-fifth of those who were at least 10 years of age. In this part of the population was included a small element who had received superior education. They numbered only 76,627, or 1.6% of the population over 10 years of age.

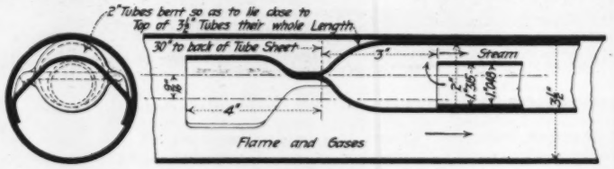
Those having received a superior education represent fairly closely the higher classes, a discussion of whose characteristics is not attempted in this paper.

Another classification of the Filipino people is that of civilized and wild people. The civilized tribes form 91% of the total population, and of this proportion the Bisaya, Tagalog, Ilocano, and Bicol, form 46.8%, 21.2, 11.7, and 8.2%, respectively, a total of 88% of the civilized people. While these various tribes and classes differ materially in traditions, habits and dialects, not only with each other, but also among themselves, yet the influence of the Spanish Church and Government during the past three centuries has created a similarity in customs and in types of dwellings.

Published accounts, both official and unofficial, present such a variety of conflicting opinions regarding the Filipinos as to compel the remark that no general statements—except fundamental truths applicable to all mankind—can be made applicable to all tribes. The numerous dialects and customs characteristic of almost every barrio or small village, the exclusiveness of each settlement or the lack of inter-communication between settlements, the various racial characteristics of the somewhat large mestizo* portion of the population, and the broad division between the high and low classes may be sufficient reason for such discrepancies in the opinions of travelers and other observers.

The principal agricultural products of the islands are hemp, or abaca, sugar, tobacco, cocoanut, coffee, rice, cacao, lumber, dyewood, fruits, vegetables, etc. The principal building materials are poles or bamboo for the framework; nipa palm or grass for the roofing, and the same material or split and woven bamboo for the siding; and bejuco or rattan for binding. Nails and bolts are never used in the construction of the simple native dwellings.

The manufactured products throughout the islands for the year 1902 aggregated in val-



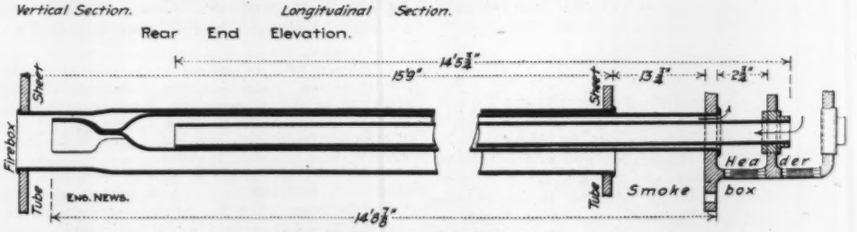


FIG. 3. ARRANGEMENT OF SUPERHEATER TUBES.

*Consulting Engineer to the Philippine Commission, Manila, P. I.

*Offsprings of mixed parentage. A large percentage have a Filipina mother, and a Spanish or Chinese father.

TABLE I.—MAXIMUM VELOCITY OF THE WIND, RECORDED IN MANILA IN THE INTERVAL OF ONE HOUR DURING THE MONTHS OF JANUARY AND SEPTEMBER, FOR THE PERIOD 1885-98.

Year.	January.				September.			
	Kilometers.	Miles.	Date.	Hour.	Kilometers.	Miles.	Date	Hour.
188	37.0	22.9	22	2-3 p.m.	57.0	35.3	4	1-2 p.m.
188	35.0	21.7	30	1-2 p.m.	44.8	27 8	8	1-2 p.m.
188	22.7	14.1	8	3-4 p.m.	79.0	49.0	19	2-3 p.m.
188	27.2	16.9	21	5-6 p.m.	69.5	43.1	27	2-3 a.m.
188	25.0	15.5	15	0-1 p.m.	35.7	22.1	24	11-12 m. / 1-2 p.m.
188	23.8	14.8	3	11-12 m.	100.0	62.1	30	7-8 a.m.
189	28.0	17.4	25	3-4 p.m.	16.0	28.8	6	1-2 p.m.
1891	23.3	14.4	26	4-5 p.m.	45.1	28.0	7	0-1 a.m.
1892	29.0	18.0	27	0-1 a.m.	90.0	55.8	30	11-12 midnight
1893	27.0	16.7	22	3-4 p.m.	89.0	55.2	17	9-10 a.m.
1894	28.4	17.7	29	1-2 p.m.	65.0	40.3	4	6-7 a.m.
1895	23.4	14.5	24	4-6 p.m.	44.5	27.6	12	4-5 p.m.
1896	36.5	22.6	1	2-3 p.m.	57.0	35.3	14	0-1 p.m.
1897	30.0	18.6	7	2-3 p.m.	31.5	19.5	15	3-4 p.m.
1898								
Average	28.3	17.5			61.0	37.8		

TABLE V.—Showing Percentage of Population Engaged in Gainful Occupations.

Country.		Percentage of Total population.	Males.	Females.	10-14 years of age.
Philippine Islands	(1903)	43.5	57.6	29.4	16.8
Cuba	(1899)	39.6	68.2	8.8	24.6
United States	(1900)	36.3	58.7	12.8	14.8
Porto Rico	(1899)	33.1	56.9	9.9	22.4

TABLE VI.—Records of Medical Inspections of Seamen by the U. S. Public Health and Marine Hospital Service, Manila, P. I., from January, 1904, to July, 1905.

Age Inclusive.	Number measured.	Average height.	Average weight, lbs.
14 to 17	25	5′ 1.00″	96.72
18	29	5′ 3.43″	108.43
19	31	5′ 4.57″	118.63
20 to 23	138	5′ 3.31″	115.85
24 to 30	303	5′ 3.51″	120.30
31 to 40	267	5′ 3.09″	125.63
41 to 64	153	5′ 3.80″	134.51

TABLE VII.—Average Weight and Height of Filipinos. (From Records of Philippine Civil Service Board.)

Age.	Number examined.	Average weight. (Stripped.)	Average height. (Barefooted.)
Native Keepers and Guards at Bilibid Prison:			
19	1	100.5	5′ 3″
20-22	13	113.07	5′ 4.17″
23-30	15	113.57	5′ 3.52″
31-40	11	114	5′ 4.43″
Native Patrolmen in Manila Police Force:			
18	2	114	5′ 5.81″
19	5	119.60	5′ 5.98″
20-22	27	115.59	5′ 5.35″
23-30	73	119.32	5′ 5.61″
31-40	40	125.80	5′ 5.64″
Native Government Employes in the Oriente Building:			
17	4	83.75	5′ 1.25″
18	7	98.57	5′ 2.78″
19	9	100.	5′ 4.32″
20-22	21	101.09	5′ 3.71″
23-30	43	108.	5′ 3.66″
31-40	17	104.70	5′ 3.08″
41-50	2	114.	5′ 1.02″
	103		

(Pesos) 35,097,209, of which 67.2% were made in Manila. The number of persons employed in manufacturing establishments was 34,659. Valuable information on products—both agricultural and manufactured—is contained in the 1903 Census of the Philippine Islands, from which Table IV. is taken.

Of the total area of the Islands, 2,827,704 hectares (about 7,000,000 acres) or 9.5% is agricultural land, 45.9% of which is under cultivation; 1,162,108 native males, or nearly one-third of the total number of native males, are engaged in agricultural occupations. The Census Report gives a total of 815,453 farms; all but 4.8% of which have an area less than 5 hectares (13.37 acres); 63.3% are less than 1 hectare (2.47 acres); and 35.7% are less than 0.35 hectare, or smaller than a lot 194 ft. square.

While the Filipino is engaged in but few occupations, and these mostly of an individual rather than a cooperative nature, statistics show that he cannot be correctly regarded as a non-worker or non-producer. Table V is compiled from the Census Report.

The tools ordinarily used are of the crudest sort and modern machinery has been practically unknown. However, under proper instruction, the native has shown a fair degree of skill in operating more or less complex machinery, such as steam derricks, drills, locomotives, engines, and stone crushers.

As a measure suggestive of the physical strength of the Filipinos, Tables VI. and VII. have been compiled from the sources indicated. The militia age is from 19 to 59, inclusive; the voting age is from 23 upwards.

This record is limited to men who were born in the Philippine Islands; it probably involves an error, since a few were doubtless Spaniards, and a larger number mestizos. The average heights and weights may therefore be somewhat higher than they would have been had a more accurate determination of race been possible. In any case they are typical of the laboring classes. Table VII. has been compiled from records taken of Civil Service employes.

A summation of measurements of Bilibid prisoners made by Dr. Folkmar gives the following results:

Number of men, 838; average height, weight, and age, 5 ft. 3 ins., 116.8 lbs., and 31 years, respectively. The maximum and minimum ages of

TABLE II.—CAUSES AND CIRCUMSTANCES OF THE MOST ABUNDANT RAINFALLS WHICH HAVE OCCURRED WITHIN ONE HOUR OR PART THEREOF: 1885-1902.

Year.	Date.	Hour.	Amount of rain. mm.	Amount of rain. ins.	Cause of rain.	Observations.
1892	May 21	5-6 p.m.	60.0	2.4	Intense local thunderstorm	These 60 mm. were registered by the pluviograph Cassella in 30 minutes.
1891	June 15	7-8 p.m.	55.0	2.2	Influence of distant pressure	In 8 minutes, 50 mm. were collected.
1887	Sept. 18	6-7 p.m.	52.5	2.1	Intense thunderstorms	The pluviograph registered 40 mm. in 30 minutes.
1899	July 19	1-2 a.m.	51.3	2.1	Thunderstorm influenced by distant hurricane.	We found 20 mm. registered in 15 minutes.
1891	Sept. 15	5-6 p.m.	50.3	2.0	Influence of distant hurricane	20 mm. were registered in 12 minutes.
1890	July 16	5-6 p.m.	50.0	2.0	Distant hurricane in the north	
1891	Nov. 16	3-4 p.m.	49.8	2.0	Influence of a hurricane which crossed near the south of Manila	
1902	June 1	4-5 p.m.	48.5	1.9	Thunderstorm influenced by a hurricane toward the east	
1889	Aug. 6	2-3 p.m.	48.0	1.9	Thunderstorm	In 7 minutes, 50 mm. were registered.
1889	June 30	2-3 p.m.	47.2	1.9	"	In 20 minutes, 30 mm. were registered.
1898	Sept. 14	1-2 a.m.	47.2	1.9	Distant pressure	In 17 minutes, 25 mm. were registered in the pluviograph.
1888	Aug. 27	2-3 a.m.	47.0	1.9	" "	
1888	Sept. 17	7-8 p.m.	47.0	1.9	Thunderstorm	45 mm. of water fell in 35 minutes.
1897	Aug. 28	3-4 p.m.	46.0	1.8	Intense local thunderstorm	40 mm. registered in 16 minutes.
1894	Mar. 9	0-1 p.m.	45.8	1.8	Thunderstorm	
1896	Sept. 6	1-2 a.m.	44.0	1.7	"	20 mm. collected in 15 minutes.
1888	July 23	4-5 a.m.	42.8	1.7	"	
1886	Aug. 26	5-6 p.m.	42.0	1.7	"	15 mm. registered in 15 minutes.
1891	May 29	7-8 p.m.	42.0	1.7	"	20 mm. registered in 10 minutes.

TABLE III.—SUMMARY OF THE MOST IMPORTANT FEATURES OF TEMPERATURE IN MANILA, DEGREES CENTIGRADE.

Month	Mean derived from hourly observations (22 years).	Mean departures of the means (22 years).	Daily range of temperature.	Hours of minimum and maximum. Max. p.m.	Hours of minimum and maximum. Min. a.m.	Mean monthly and annual extremes (20 years.) Max.	Mean monthly and annual extremes (20 years.) Min.	Mean monthly and annual range.	Absolute extremes. (22 years.) Maximum.	Absolute extremes. (22 years.) Minimum.
January	25.1	−1.8	7.6	3	6	32.1	17.9	14.2	33.9 (14, 1897)	15.6 (27, 1881)
February	25.6	−1.3	8.5	3	6	32.9	18.0	14.9	35.4 (24, 1892)	15.7 (27, 1902)
March	26.9	0.0	8.6	3	6	34.3	18.5	15.8	35.6 (28, 1901)	17.2 (2, 1899)
April	28.4	+1.5	8.9	3	6	35.5	20.8	14.7	37.2 (30, 1889)	18.7 (9, 1902)
May	28.8	+1.9	7.0	2	5	36.1	22.7	13.4	37.8 (23, 1889)	21.3 (4, 1901)
June	28.0	+1.1	6.0	2	5	35.0	22.6	12.4	36.8 (1, 1881)	21.1 (30, 1881)
July	27.2	+0.3	5.0	1 / 2	5 / 6	33.5	22.4	11.1	35.2 (10, 1881)	21.0 (11, 1881)
August	27.2	+0.3	4.8	1	6	33.0	22.3	10.7	35.2 (22, 1882 / 6, 1900)	20.6 (27, 1896)
September	27.1	+0.2	4.6	1	6	33.3	22.4	10.9	35.2 (29, 1901)	20.9 (22, 1902)
October	27.0	+0.1	5.7	1 / 2	6	33.3	21.4	11.9	34.9 (24, 1891)	19.6 (24, 1902)
November	26.2	−0.7	5.9	1 / 2	6	32.2	20.3	11.9	34.2 (15, 1882)	17.3 (29, 1880)
December	25.2	−1.7	6.2	2	6	32.1	18.3	13.8	33.4 (3, 1900)	15.7 (31, 1892)
Year	26.9	.....	6.5	....	....	33.6	20.6	13.0	*37.8 May 23, 1889	*15.6 Jan. 27, 1881

* These two values are the maximum and minimum during the period 1881-1902.

TABLE IV.—PHILIPPINE MANUFACTURES, BY INDUSTRY GROUPS: 1902.

Industry group.	Number of separate industries.	Number of establishments.	Capital (pesos).	Average number of wage-earners and total average monthly wages—Total. Number.	Total. Wages (pesos).	Men. Number.	Men. Wages (pesos).	Women. Number.	Women. Wages (pesos).	Cost of materials purchased (pesos).	Value of products (pesos).
All industries	68	2,184	36,226,085	34,659	757,841	27,045	670,270	7,614	87,571	25,049,452	35,097,206
Group 1. Food and kindred products	5	456	1,721,976	2,757	43,698	2,412	40,973	345	2,725	2,228,963	3,417,143
Group 2. Textiles	11	230	895,483	3,456	47,741	1,924	31,919	1,532	15,822	776,118	1,600,776
Group 3. Metal products	8	161	1,054,346	1,724	44,669	1,716	44,534	8	135	490,030	1,208,816
Group 4. Lumber and its manufacture	8	133	2,995,754	2,039	46,822	2,011	46,424	28	398	1,506,662	3,177,906
Group 5. Leather and its products	4	219	686,135	1,498	34,241	1,337	32,497	161	1,744	525,928	1,132,558
Group 6. Printing and allied industries	4	39	1,200,623	1,138	40,811	1,051	40,069	87	742	230,375	1,115,928
Group 7. Liquors and beverages	2	331	4,427,287	2,541	45,210	2,413	44,595	128	615	2,478,042	4,787,718
Group 8. Chemicals and allied products	6	92	516,522	1,151	26,736	1,066	25,315	85	1,421	233,249	419,244
Group 9. Clay and stone products	4	87	327,716	1,393	15,493	1,367	15,150	26	334	119,985	615,642
Group 10. Tobacco	2	113	4,500,403	10,150	138,112	5,223	78,923	4,927	59,189	4,339,682	8,740,516
Group 11. Miscellaneous industries	14	323	17,899,840	6,812	274,308	6,525	269,862	287	4,446	12,060,418	8,791,259

men measured were 55 and 20 years, respectively.

The cargadores, or pack-carriers, especially of the hemp regions, and of the mountains, exhibit remarkable physical development and a high degree of endurance.

The common native food is rice, corn, and dried or fresh fish, with such fruits and vegetables as may be available. It has been demonstrated by the army, in rationing the scouts or native soldiers, that a material increase in strength and endurance results from a more suitable ration similar in character to the regular army ration.

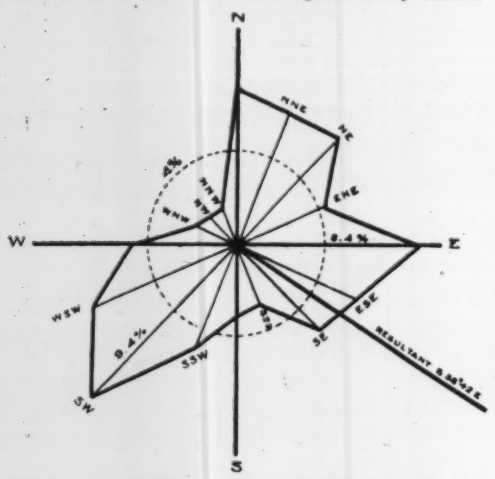


Fig. 1. Annual Progression of the Winds at Manila, P. I.

The adoption of the U. S. Army Scout ration among the native employes of the Mariveles Quarantine Station has resulted in a considerable increase in weight and a marked increase in efficiency and endurance.

With American system and methods there may be expected an increase in the use of nitrogenous foods and a proportional increase both in efficiency and in wages.

Statistics show that malarial fevers seriously interfere with the efficiency of labor gangs. Its effects can be successfully met by the use of its specific remedy, quinine, the value of which is slightly known by the native.

Cholera, usually regarded as a filth disease, is sporadic and at times epidemic in its nature. It was prevalent practically throughout the Islands during the summer of 1902. It must be combated with rigid quarantine regulations, which, while effective in stamping out the disease, necessarily cause additional expense and delays in prosecuting public works. Improved and rigid sanitary measures will doubtless prevent in a large measure the future ravages of this disease.

Other tropical diseases, as leprosy and bubonic plague, are practically negligible in their effect on labor gangs. Yellow fever is at present unknown.

The Board of Health is thoroughly organized with an ample and efficient force. During the eleven months ending Aug. 1, 1905, its staff of medical inspectors had vaccinated 819,439 persons throughout the Islands, and the Presidents of Municipal Boards of Health had vaccinated 164,933. Vaccine units to the number of 3,034,900 were shipped to points throughout the Islands. This does not include the records of the Army, Navy, and Marine Hospital service, or the work of private physicians. The effective work cited was of a routine nature, and was not the result of an epidemic of smallpox. It has, however, practically stamped out this disease previously so prevalent.

Table VIII., from the Philippine Census Report, shows a comparison between the causes of death in the Philippines and the United States for the year 1902, during which cholera was pandemic.

Table IX. shows the average density of population per square mile throughout the provinces.

The density of population is dependent upon topographical features and resources. Along the fertile coastal plains and river valleys where public improvements are first required, the population per unit area is from 3 to 10 times as great as the average population per square mile.

The density of population for the United States proper is 25.6 persons per square mile. The following figures, referring to the principal agricultural regions, and the principal manufacturing states are compiled from the United States Census 1900, and are given for comparison with those of the Philippine Islands.

States.	Area square miles.	Average population per square mile.
Agricultural States.		
Arkansas	53,850	24.7
Indiana	36,350	70.1
Iowa	56,025	40.2
Kansas	82,080	18.0
Michigan	58,915	42.2
Nebraska	77,510	13.9
Wisconsin	56,040	36.0
Manufacturing States.		
Connecticut	4,990	187.5
Illinois	56,650	86.1
Massachusetts	8,315	348.9
New Jersey	7,815	250.3
New York	49,170	152.6
Pennsylvania	45,215	140.1

The following brief tables for other countries are presented for the purpose of comparison:

Area and Population of Cuba, Porto Rico and Hawaii. (Taken from Census, 1899.)

Country.	Area square miles.	Population. Total.	Population. Per square mile.
Cuba	44,000	1,572,797	36
Porto Rico	3,606	953,242	264
Hawaii	4,990	154,001	31

Area and Population of Certain Other Countries.

Country.*	Area square miles.	Population. Total.	Population. Per square mile.
Japan	161,198	46,558,700	289
Jamaica	4,200	745,104	177
Java	50,554	26,000,000	514
New Zealand	104,471	816,000	8
Sumatra	161,612	3,209,037	19
Tasmania	26,385	171,066	6

*Figures taken from International Year Book, 1901.

TABLE VIII.—Distribution of Deaths in the Philippine Islands and in the United States for the year 1902 by Principal Causes, Expressed in Percentages of the Total Number of Deaths (Condensed).

Cause of Death.	Philippine Islands.	United States.
Cholera	31.1	....
Malarial fever	26.8	1.4
Tuberculosis of the lungs	6.6	10.7
Dysentery	3.7	1.1
Smallpox	3.4	0.3
Diarrheal diseases	3.2	3.3
Beri-beri	1.3	....
Diseases of stomach	1.2	1.3
Bronchitis	0.7	1.9
Tetanus	0.6	0.2
Influenza	0.4	1.6
Typhoid fever	0.4	3.4
Diphtheria	0.3	1.6
Simple meningitis	0.2	1.2
Erysipelas	0.2	0.3
Rheumatism	0.2	0.5
Scarlet fever	0.1	0.6
Whooping cough	0.1	0.9
Dengue	0.1	....
Cancer	0.1	2.8
Organic diseases of heart	0.1	6.7
Pneumonia	0.1	10.2
Nephritis & Bright's disease	0.1	3.5
Bubonic plague	!	....
Leprosy	!	....
Suicide	!	0.5

! Represented.

TABLE IX.—Total Areas, Population and Density of Population per Square Mile, by Provinces.

Province.	Area sq. miles.	Total population.	Average total.
Albay	1,649.5	240,326	145.6
Ambos Camarines	3,540.1	239,405	67.6
Antique	1,052.5	134,160	127.4
Bataan	518.9	46,787	90.1
Batangas	1,305.8	257,715	197.3
Benguet	908.3	22,745	25.0
Bohol	1,510.4	260,223	172.3
Bulacan	965.3	223,742	231.8
Cagayan	5,172.5	156,239	30.2
Capiz	1,755.4	230,721	131.5
Cavite	708.1	134,779	190.3
Cebu	1,938.4	653,727	337.3
Ilocos Norte	1,348.3	178,995	132.8
Ilocos Sur	1,739.8	239,271	137.5
Iloilo	2,102.1	410,315	195.2
Isabela	4,789.3	76,431	15.9
La Laguna	666.2	148,606	223.1
La Union	708.4	137,839	194.7
Lepanto-Bontoc	2,221.3	72,750	32.7
Leyte	3,007.8	388,922	129.3
Masbate	1,569.2	43,675	27.8
Mindoro	4,023.7	39,582	9.8
Misamis	3,346.1	175,683	52.5
Moro	28,520.6	380,038	13.3
Nueva Ecija	2,127.9	134,147	63.0
Nueva Vizcaya	1,693.2	62,541	37.0
Occidental Negros	3,145.5	308,272	98.0
Oriental Negros	1,848.6	201,494	109.1
Pampanga	872.6	223,754	256.3
Pangasinan	1,889.0	442,521	234.3
Paragua	5,237.8	35,696	6.8
Rizal	898.5	150,923	168.0
Romblon	572.6	52,848	92.2
Samar	5,276.1	266,237	50.5
Sorsogon	542.4	120,495	222.3
Surigao	7,023.2	115,112	16.4
Tarlac	1,231.3	135,107	109.7
Tayabas	5,997.8	204,739	34.1
Zambales	1,589.2	59,930	37.7
Totals	115,013.7	7,415,498	
Manila (City)	12.3	219,928	
Total for the Phil. Islands	115,026.0	7,635,426	66.4

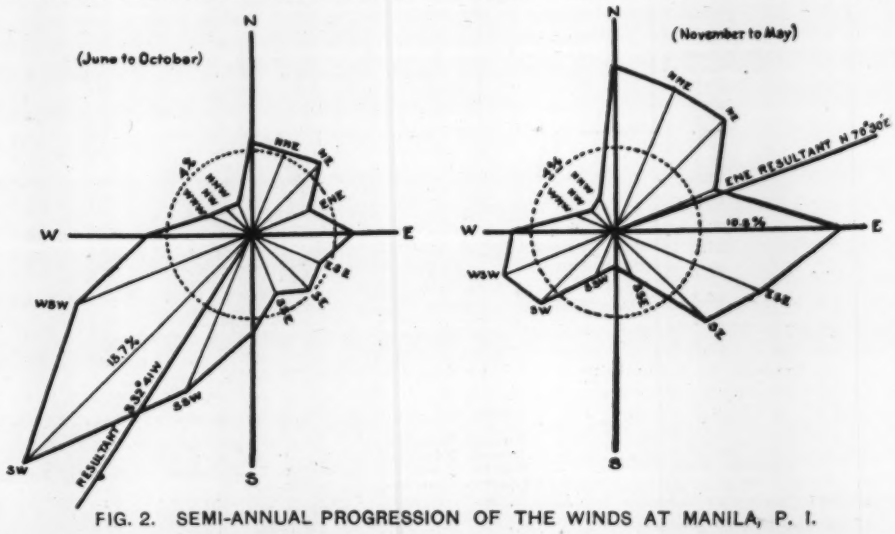


FIG. 2. SEMI-ANNUAL PROGRESSION OF THE WINDS AT MANILA, P. I.

Under present conditions contractors and engineers located in the Philippine Islands will find it advantageous to give special instructions to American exporters shipping goods into the islands, in order that customs regulations may be complied with and unnecessary delays avoided; that goods may be properly protected against serious deterioration from sea-water and ordinary handling while in transit; and that essential parts shall not be lost for months in some way port. The American exporter, in comparison with the foreign exporter, is often seriously discredited by importers in the Philippines on account of his lack of attention to these details. He certainly exceeds all others in the careless packing of export goods.

Outside of the larger cities, transportation by land is expensive on account of the lack of local facilities and the condition of highways, and the contractor will find it economical to organize and control the necessary transportation equipment. The Government is pursuing a progressive policy relative to the improvement of the highways. Water transportation has furnished the most important means of conveyance for centuries. A large percentage of the inhabitants are skilled in the use of the various small native crafts. Coastwise vessels are too limited in both size and numbers to meet the present demands; they are owned and operated mainly by local firms. Important legislation and improvements relative to coastwise commerce are now in progress and will be completed early in 1906.

The following statements are compiled from reports by the Provincial Supervisors, and are the average figures from 36 provinces. They relate only to the expenses of American officials assigned to one location for at least several months. Incl-

TABLE XI.—WHOLESALE PRICES OF FOODSTUFFS: MAXIMA AND MINIMA PRICES.
(In Mexican Currency: From Smith, Bell & Co.)

	1890. Max.	1890. Min.	1895. Max.	1895. Min.	1900. Max.	1900. Min.	1905. Max.	1905. Min.
Saigon rice (picul)[1]	$3.50	$2.60	$4.00	$3.19	$5.55	$4.65	$5.60	$4.60
Flour (picul)	8.75	8.25	9.75	9.00	13.50°	11.50°	11.75°	10.40
Refined sugar (200 lbs.)	12.00	7.50	10.50	8.00	16.00	14.00	13.50	10.00

[1] 1 picul = 136 lbs.
°Warner, Barnes.

dental expenses include hire of servant, laundryman, keeper of horse, etc.

	U. S. Currency.
Subsistence per month, averages	$32.
Lodging per month, averages	10.50
Incidentals per month, average	15.
Total	$57.50

Superintendents of construction works and civil engineers in charge of field parties purchase subsistence supplies in bulk, they are quartered in tents or nipa shacks, and purchase locally, fruits, vegetables, chickens, eggs, etc., whenever practicable. Subsistence expenses per month for Americans average $27, and for native laborers about $5.

Tables XI. to XIV. have been prepared from the most reliable available sources. Abnormal conditions have prevailed since the American occupation. Until recently the currency of the Islands has been on a fluctuating silver standard. Fluctuations as high as 30% within a few weeks have been known. The currency of the Islands, however, is now firmly established on a gold standard, the unit of value being the peso, which is equivalent to 50 cts. United States currency. Rentals have been excessive and all items entering into the cost of living, except clothing, have been abnormally high. During 1905 the market value of rentals and of food stuffs is materially lower than during the period 1900 to 1905, and it can be reasonably anticipated that, with increased inter-island and transpacific service, and equitable tariff relations established with the United States, the previously excessive cost of living will not again prevail. The value of these tables is of importance mainly in showing the prices prevailing previous to 1905.

The average value of the Mexican peso for the years involved in Tables XI., XII., XIII. and XIV. follows:

Year	1890	1895	1897	1898	1900
U. S. Currency	$0.8368	$0.552	$0.5024	$0.4711	$0.4918
Year	1901	1902	1903	1904	1905
U. S. Currency	$0.4872	$0.424	$0.419	$0.4671	$0.50

The value of local peso in above table, in terms of United States currency was computed by Dr. E. W. Kemmerer, Chief, Division of the Currency, on the basis of average daily sterling exchange rates in Manila, reckoning 4.8665 to the pound sterling. The new Philippine currency was adopted in 1904, one peso (P) being equivalent to $0.50 U. S. currency.

In general the Filipino is a Malay, modified, except in the Moro, to a considerable degree by the influence of centuries of associations with other races, and more particularly by the civilizing influences of the Church and the Government of Spain.

Nature has freely endowed the islands with food available with a minimum of effort through the year. She does not require that provisions be made for an extended winter; nor is there a season during which some food stuffs are not procurable in the field. That thrift characteristic of inhabitants of higher latitudes is entirely lacking in the average Filipino. He has been subjected by foreign races, and through the necessity of existence he has become highly skilled in both detecting and practicing deception. He has been required to defend his family from pirates and ladrones. He has, perhaps, in past times, played the part of both. As a result, he is a mass of contradictions, and is in general proud, hospitable, indolent, and unreliable. His family ties are strong. He is imitative and quick to learn, but his capacity remains to be determined. He may be defined as a child in whom the faculties and habits are not fully matured. As a laborer, it is an absolute necessity that he receive patient, careful instruction and efficient supervision from a superintendent or foreman acquainted with his characteristics; that he clearly understands the orders given; that the demands placed upon him be within his ability; that he be instructed from the first in the right way to perform new duties, and be not required to unlearn lessons or methods previously taught. He is quick to recognize efficiency and justice in his employer, and to repose confidence in the foreigner possessing these traits. He is favorably impressed by an outward show of wealth and influence. The custom of English commercial firms upon entering new fields of operations is to construct ample warehouses and residences for their representatives. These buildings are generally the most substantial and best furnished in the town. They could be easily fortified to resist attacks by mobs. This plan not only provides for the security and efficiency of the representatives of the firm, but it pays as an advertisement as well—it creates in the minds of the surrounding inhabitants confidence, and inspires a desire to trade with a firm of such evident wealth and power.

The employer of a considerable number of men for a period of several months must provide for the sanitation, subsistence, amusements and religion of the employe and his family.

A brief description of the employes' settlement at the quarries of the Atlantic, Gulf & Pacific Co. will clearly illustrate this point. This firm has under prosecution the contract for the Manila breakwater and harbor dredging, the total cost of which will be approximately $4,000,000. The quarries are located on the westerly shore of Manila Bay, about 25 miles from the harbor works. The employes consist principally of about an equal force of Tagalo and Pampangans. The contractors have an experienced and efficient superintending force. They have provided pure water for the settlement, and enforced regulations relating to sanitation and policing; gambling is prohibited inside of the houses. About 700 employes are engaged; 150 houses have been built for their families; and material for a church has been furnished, the labor having been provided by the settlement, and the erection superintended by the contractor. A cock-pit and dance-hall were built and the time of attendance regulated; the children have been provided with a school and the services of a native teacher have been secured through the Bureau of Education; a store for the supplies demanded by the settlement has been established, at which necessary goods are sold at practically cost prices, and the paymaster, if desired, acts as banker for the more thrifty employes. The cost of these provisions for the needs and pleasures of the employes has been comparatively small by reason of the fact that the materials of construction have been available locally. The amount of common sense and the practical knowledge of the native characteristics shown by this Company has been large. As a result of the above-mentioned provisions, and by a process of elimination, selected laborers have been secured for long periods of service, and they have been trained to considerable efficiency in lines requiring semi-skilled labor. Mr. H. Krusi, Vice-President of the Company, in charge of this work, states that native labor is entirely satisfactory. In view of large contracts under advertisement, he declines to give at present detailed information on the efficiency or unit output per day of the native laborers.

A large portion of the data presented relative to the facility in securing labor, its efficiency, and wages paid, applies to Manila and its vicinity. The best information available on labor throughout the Provinces may be secured from an examination of the reports of the Provincial Supervisors, who are, as a rule, trained civil engineers, and whose official duties require them to organize and superintend all public works in the Provinces. They are generally engaged on projects financed with insular, municipal, or provincial funds.

Wages in Manila and vicinity, and in the hemp regions, average about one peso (50 cts.) per day. The average rate through the provinces is somewhat less than one-half peso; during the planting and harvesting seasons labor may be scarce, and difficult to secure at somewhat higher prices, but lower rates prevail during the remainder of the year.

In general it may be noted that the hire of labor, as well as the purchase of local material, can be accomplished more readily when small rather than large quantities are required; the difficulties to the Filipino contractors in the organization and prosecution of the larger projects are materially increased, and they refuse to undertake such contracts.

Experience in handling the larger projects has not yet been acquired, although there is a favorable tendency to a more successful meeting of such demands. In other words, laborers in small numbers can be readily secured for short periods of time; laborers in large numbers for continuous service are difficult to secure, and require tact and skill in providing with such conveniences, amusements and home-life, as are necessary to hold the laborers for long periods. When such local amusement or relaxation is not provided, the Filipino laborer leaves his work at frequent intervals to visit his home and friends, for fiestas, and for the harvesting and planting of crops.

The following abstracts from the reports of the Supervisors for the past fiscal year on the question of unskilled labor are typical; it is probable that over 60,000 different native laborers have been employed during the past year by these officials:

NUEVA ECIJA.—During the past year I have had little trouble in securing labor whenever desired. During the rice harvesting season it is more difficult to obtain labor

TABLE XII.—Comparative Retail Prices of Foodstuffs in Manila.

Item.	Unit.	1897. Pfs.	1898. Pfs.	1901. Pfs.	1904. Pfs.	1905. Pesi
Sugar	arroba	1.82	2.50	2.94	3.50	3.00
Rice	"	2.00	3.00	3.00	3.50	3.50
Spanish peas	"	5.00	7.50	7.00	7.00	8.00
Beans	"	2.00	3.00	4.00	4.00	3.50
Coffee	"	8.00	10.00	10.00	10.00	9.00
Potatoes	"	0.75	5.00	1.36	2.00	1.50
Onions	"	2.00	6.00	3.00	3.00	1.50
Codfish	"	4.00	6.00	7.00	8.00	6.25
Red wine	"	3.00	4.00	6.00	6.00	5.00
White wine	"	4.00	5.00	7.00	20.00	7.00
Sherry	case	11.00	11.00	16.00	22.00	18.00
Vinegar	arroba	3.00	3.50	4.50	5.50	7.00
Vinegar	bottle	0.37	0.50	0.50	0.50	0.40
Olive oil	arroba	4.00	5.50	7.50	7.50	5.75
Olive oil	bottle	1.00	1.50	1.50	1.50	0.90
Alcohol (36)	"	0.25	0.37	0.37	0.50	0.50
Pickles	"	0.50	0.75	0.87	1.00	0.50
Olives	"	0.50	0.50	0.70	1.00	0.60
Olives	firkin	1.00	1.50	1.50	2.00	1.25
Lard	arroba	4.00	5.00	6.00	7.60	5.00
Canned butter	pound	0.75	1.00	1.12	1.25	0.60
Kerosene 10 gls.	case	4.00	5.50	5.00	5.00	3.20
Bacon	pound	0.37	0.50	0.55	0.62	0.45
Soda biscuit	can	1.25	1.75	2.00	2.00	0.50
Can sardines	"	0.10	0.20	0.20	0.50	0.15
Can fish	"	0.37	0.50	0.75	0.75	0.50
Can meat	"	0.62	0.75	1.00	1.25	0.50
Can sausage	"	1.00	2.00	1.50	1.50	0.45
Can pork	"	2.50	2.50	3.25	3.50	2.00
Can sugar	"	0.75	0.87	1.00	1.25	1.20

Arroba = 25 lbs.
Pfs. is the designation for Mexican currency, and Pesos for the new Philippine currency.

TABLE XIII.—Imports and Exports of Foodstuffs, Philippine Islands, American Period.
(From Third Special Report of the Philippines Customs.)

	1901.	1902.	1903.	1904.
Imports.				
Cattle, hogs, sheep	$77,413	$487,326	$740,076	$844,482
Breadstuffs	746,187	923,540	912,087	1,006,332
Cocoa, coffee, tea	199,899	301,859	318,834	276,593
Opium	619,338	819,625	721,551	770,506
Eggs	285,239	276,085	294,414	282,074
Malt liquors	1,042,594	547,517	488,131	310,411
Beef, fresh	19,286	31,518	82,155	204,262
Hog products:				
Hams, shoulders	110,744	157,663	155,130	167,181
Lard	92,139	120,059	185,894	262,140
Condensed milk	97,287	155,595	247,366	251,261
Rice	5,490,958	6,578,481	10,061,323	11,548,814
Spirits	411,859	510,258	307,681	227,578
Wines	347,216	390,393	258,912	266,663
Vegetables	328,674	686,254	412,904	432,578
Canned goods	112,430	286,191	233,673	282,599
Fruits	114,644	146,963	78,407	87,998
Olive oil	36,370	30,863	46,977	41,835
Cheese	58,987	40,633	43,959	38,518
Butter	88,446	62,583	48,401	56,583
Fish	53,542	81,348	52,152	112,201
Exports.				
Sugar, raw or brown	2,203,058	2,761,432	3,955,828	2,668,507
Coffee	—	—	—	—
Rice	—	—	—	—

TABLE XIV.—Comparative Cost of Foodstuffs in Manila.

	1897 Pfs.	1900 Pfs.	1904 Pfs.	1905 P
1 lb. meat without bone	0.25	1.50	0.60	0.30
First-class rice, sack	2.50	5.75	7.50	6.50
Pork, per pound	0.20	0.50	0.70	0.40
1 chicken	0.15	0.50	0.60	0.75
1 hen	0.50	1.25	1.50	1.25
1 piece of bread	0.01	0.04	0.04	0.02
1 measure milk	0.05	0.15	0.25	0.20
Water (2 buckets)	0.01	0.05	0.05	0.04
Fish, per pound	0.12	0.25	0.50	0.25

Pfs. is the designation for Mexican Currency.
P for the new Philippine Currency.

than at other seasons, as laborers receive more in proportion for harvesting rice than at other work. As a rule, it is difficult to obtain carabao and carts for public work. And during about eight months of the year it is practically impossible to get them at any reasonable figure—this during rice planting and harvesting seasons. To meet these conditions the province has purchased carts, American mules and wagon, and I have

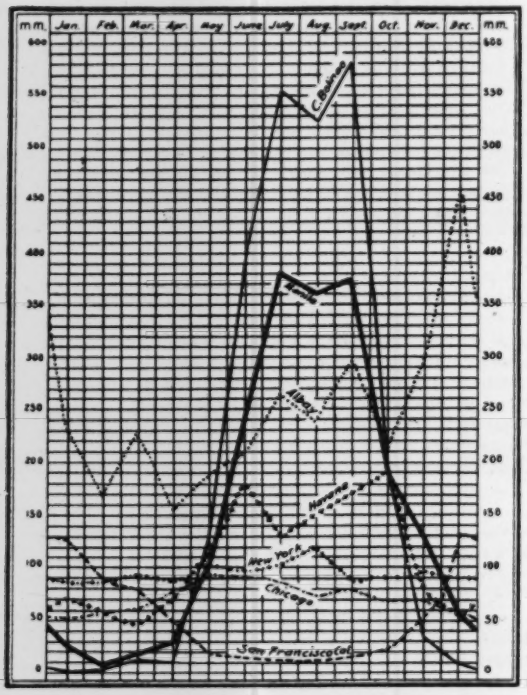


Fig. 3. Annual Variation of Rain in Various Places of the Philippine Archipelago, of the Antilles and of the United States.

made log wagons and other vehicles for use on public works.

A marked improvement is noticeable in semi-skilled native labor, if properly directed for any considerable length of time....I do not think that it would be questioned that labor conditions at the present time are superior to those at any previous period since American occupation.

BATANGAS.—Natives were almost entirely employed on all public works....Economic conditions in the province are such at present that no difficulty was encountered in securing the necessary number of laborers at the rate (40 cts.) specified. It is evident, however, that within the course of a year or two agriculture will have recuperated to such an extent that wages will be considerably higher, as the demand for labor increases.

RIZAL.—Hundreds of laborers found employment at Fort McKinley as painters, carpenters, and ordinary laborers at good wages, and at times I had difficulty in getting labor for my road work. The lowest wage paid for labor at Fort McKinley is 80 cts. per day, but the men are paid off but once a month. By paying the men weekly, I am enabled to get labor at 60 cts., and they will quit work at 80 cts. to work for me at 60 cts., in order that they may get their money more quickly.

TAYABAS.—While it is difficult to procure a large force of laborers and hold them together, still small gangs of 100 to 200 men can usually be kept at work except during the season of sowing and harvesting the rice crop; at such times the force dwindles down, and it is only by constant exertion that enough men can be secured to keep the work going. However, I never have as yet been obliged to shut down on account of not having sufficient men with which to do something. It is a matter of record that the people of Tayabas Province do not care to work on the roads, this probably being due to the fact that there is usually enough work to be found in looking after the numerous cocoanut plantations.

The best way to keep even such small gangs together is to pay them frequently, say at least every two weeks; then have pay-day on Sunday morning early; most of the men will spend their money during the day, and having no means of subsistence will return to work on Monday, as they are at least assured of their daily rice by so doing. These laborers, under intelligent foremen, accomplish a good day's work—left to themselves under native capataces, they are not to be depended on for one moment.

The following abstracts are taken from the report of Mayor L. W. V. Kennon, U. S. A., in charge of the Benguet Road construction:

The Filipino makes a tolerably good workman when trained and properly supervised. The class of work required on the Benguet Road was new to him and he went at it awkwardly enough at the start. Each laborer was patiently shown by a foreman how to use his tools and how to accomplish most with the least effort. Most of them attained a fair degree of efficiency and soon became good workmen. . . . . .

It may be said that after becoming inured to the work, the Filipino, considering his wage and ration, was the most economical laborer employed on the road for ordinary work. Skilled supervision is essential, however. The opinion is ventured that the Philippine Islands may be developed by native labor alone under suitable conditions. Time, tact, patient instruction and fair dealing will accomplish much; the personal equation enters very largely into the problem. . . . .

The great variety of workmen employed on the road gave opportunity for a comparison of the relative working value of the several races. The American or European, by reason of his strength, and especially by the intelligent direction of his strength, is superior to all other workmen and could accomplish more in a given time than any other. Americans were, on their merits, selected generally as foremen of the various grades.

Spaniards were among the very best laborers employed, steady, constant, industrious and hard-working always.

The Japanese were superior workmen. They were intelligent and worked well, when watched. They were fearless and active on cliff work. They furnished many carpenters and stone masons; most of them could be called upon to lay walls or to do stone work of almost any kind.

The Chinese did not turn out well and the 500 which reported were soon reduced to about 200. The majority were confirmed opium smokers and of little value as laborers and were discharged. The selected few that remained were good workers and more adaptable than Filipinos. . . . .

A few concrete examples may be of value in illustrating the labor problem. The Deputy Surveyor of Customs, Manila, in charge of lighterage, submits the following statement:

My experience has been that the Filipinos make good laborers, but only on condition that a very liberal number of foremen and superintendents be put over them, and that white men be employed as chief superintendents to do all the brain work, such as planning, directing and other executive duties. Filipino foremen of a grade of intelligence several degrees above the laborers, are necessary in liberal numbers, but these also have their limitations when it comes to head work and anything out of a routine.

The average force in the arrastre division consisted of:

150 laborers at 45 cts. per day, U. S. C.
4 stevedores (3 Filipinos—1 Chinese), $20 to $25 per month, U. S. C.

6	stationary engineers	$17	per month,	U. S. C.
2	locomotive engineers	$21-$25	" "	"
2	firemen	$10	" "	"
3	machinists	$12.50-$25	" "	"
1	carpenter (Chinese)	$25	" "	"
14	warehousemen	$15	" "	"
12	openers and packers	$15	" "	"

The superintendency for this force was one American at $1,600 per year, and three Spanish citizens of the Islands at salaries of $900, $840 and $600, respectively.

The unskilled laborers are paid each week; the skilled each month. About one-fourth of the unskilled laborers are quite regular, and another fourth fairly so; the others come and go. Three-fourths to seven-eighths cannot read or write. They generally lack intelligence. If more intelligent laborers could be procured, better wages could with economy be paid. It is not considered that the laborer at 45 cts., gold, a day is cheap. American laborers at three times the wages would be no more expensive; neither is the skilled labor cheap. The amount of work done is not large per man, compared to American standards, and the large amount of superintendence necessary, comparatively speaking, does not make this class of labor especially cheap. There is no trouble in securing laborers. Half of my force is Tagalog and half Pampangan. They are kept separate. The two do not affiliate, and there is no danger of a combination and strike as happened two years ago when all were Tagalogs.

Mr. D. M. Carman, of the firm of Carman & Co., Manila, is one of the first Americans to handle comparatively large forces of natives. He states as follows:

During a period of over five years I had in my employ, and much of the time under my immediate observation, a large number of native and Chinese laborers. This number ranged from 300 to about 2,000, and included stevedores, wharfmen, warehousemen, teamsters, lightermen, launch captain, engineers, machinists, carpenters, masons, bookkeepers, freight checkers, superintendents and managers. There are no special arrangements for housing or feeding any of these.

It was our custom to work a few gangs of Ch by the side of the Filipinos. Thus we were ena compare the character and the amount of work d each.

At the custom house we invariably paid the Ch a few cents per day more than the native, as th necessary to secure their services. While I was convinced that the natives gave us as much wo the money paid them as did the Chinamen, we re the latter as a check on the former. With the exc of the coal handlers and the carpenters the Fil gave as good satisfaction as the Chinamen. They not strong enough to carry the heavy baskets of continuously, and were not trained to do carp work. The engineers, machinists and captains launches were very satisfactory, some of them rema almost constantly at work for over four years with holidays and no vacations. One engineer and one tain were on one launch for nearly four years wit the loss of a month's time. In the early days of An can occupation there was great difficulty in kee men at work holidays, of which there were 157 in year, and it was almost impossible to induce them work over-time, but after the first few months trouble almost entirely ceased. I believe that the foll ing incident had more to do with the somewhat sud change in this particular than anything else. Notic that the petty bosses were in the habit of striking men when they did not obey promptly, or when they were at all insolent, I gave notice that any man who stru an employee would be discharged.

Shortly after issuing this one of the most import overseers hit a man and was immediately discharg From that time there seemed to be a marked change in the feelings of the men and we seldom had trouble in inducing thm to work over-time and holidays. I mention this because I have become firmly convinced that one of the secrets of securing reasonably efficient and willing service from Filipinos is the proper treatment of them.

I employed but few white foremen and some of the best bosses were natives. One of these has been in charge of the work on the custom house wharf for several years, never so far as I know having been away from his post a day, except for a week or so during a misunderstanding with the Spanish foreman, in which the latter was of fault.

In order to indicate the possibilities of development in the Filipinos, I desire to refer to a man who began

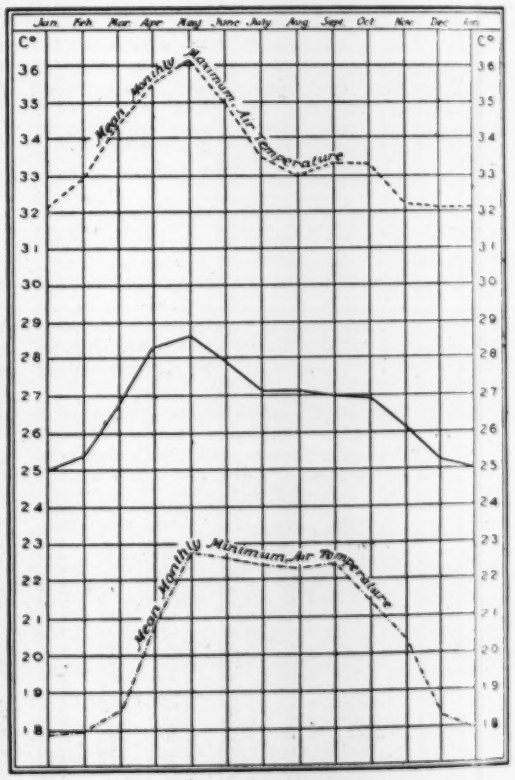


Fig. 4. Mean Monthly Temperature at Manila, 1883 to 1902.

work at forty pesos a month, and within three years managed one large department at a compensation of two hundred and fifty gold dollars per month. This man did his work with a faithfulness, honesty and competency that was exceptional.

While it is true that the Filipinos are not physically able to do as much or as hard work as similar classes of workmen in the United States, it is my belief that as much light work can be gotten out of them for a do-

lar ... be secured for a like sum from any ordinary set ... anywhere.

M... A. Belden, Manager of J. G. White & Co., ... completed the construction and equipment ... the Manila Electric Railway System, and with ... exceptions is employing native conductors ... motormen. He states:

W... had to employ more foremen than we would have ... necessary in the United States, but the cost has ... nowhere what we expected and for which we provi... in our estimates. We had been told that it would take a half a dozen Filipinos to do the work we would expect to be done by an American laborer. Results have shown, however, that the ratio of efficiency is about three to one.

We had figured on securing what Chinese and Japanese laborers we could pick up around Manila. But we decided to first give the Filipinos a thorough trial, and, as I said, the results have been excellent. We employed a few Chinamen for doing the riveting work on the power house, work at which they are supposed to excel—but we have discharged them and have employed natives in their places. Even here the natives prove themselves far the better workmen.

In response to an inquiry from the Civil Government the following statement was submitted by Mr. Krusi, to whose work reference has been previously made:

(1) We believe that Filipino labor can successfully be used. We are employing about one thousand Filipinos, which is a practical demonstration that this statement is not a theory.

(2) To employ successfully Filipino labor is, to the American employer of labor, a new business which has to be learned. If he cannot learn it, he cannot do business in the Philippine Islands.

(3) In general the Filipinos have to be taught to work. This requires a considerable proportion of intelligent, high grade American foremen and mechanics.

(4) The way to keep the Filipino laborer permanently in one's employ is to arrange his surroundings so that he is better off and more contented there than anywhere else. This we have attained by means of providing homes for the Filipinos and their families, also amusements, including Sunday fiestas and schools where their children may be educated.

(5) We are opposed to the introduction of the Chinese. The only argument is that it may somewhat expedite the development of the resources of the islands. This temporary advantage is, we believe, overbalanced and overwhelmed by the ultimate injury to both the Americans and Natives in the islands.

(6) We believe that the greatest need of the islands is the abolition of the Dingley tariff as far as it applies to the Philippines. We want the American market, not the Chinese labor.

The above two firms are today the largest representative American contractors doing business in the islands, and their projects have been described in previous issues of the Engineering News.

Mr. H. L. Higgins, General Manager of the Manila Railway, a line having a 3½-ft. gage, and extending from Manila to Dagupan, a distance of about 120 miles, is constructing about 82 miles of extension to the present system. The constructing as well as the maintenance and operating forces are composed entirely of Filipinos, except the superintendency. The permanent works require the services of about 1,300 men. Mr. Higgins has had no serious difficulty in securing laborers for new works. He states that on the new works the average period of service is about one month; that pay days occur weekly, and that wages average 50 cts. Philippine currency per day. When the work is remote from the base of supplies a commissary is established which sells necessities at prices generally under the market; no goods are sold except to laborers, and they are under no obligation to buy. No shelter has been provided laborers except when company buildings were available. Mr. Higgins estimates that in medium excavation the Filipino will handle 15 cu. m. (19.5 cu. yds.) per day; that the output per dollar expenditure compares favorably with the output of American labor, and that under improved methods and proper instruction the output will increase more rapidly than wages. On account of difficulty in securing Filipino labor in 1899, 500 Chinese were employed, at a loss in quantity and quality of work accomplished as compared with Filipino laborers. Native laborers are free from drunkenness and do not wantonly destroy property. They require efficient supervision.

The native is desirous of being his own "boss" and small contracts or section work can be let to advantage. On such work he shows perhaps double the efficiency shown on day labor. It is not uncommon for him to sleep during the middle of the day, and to work for several hours at night, either by the light of bonfires or during the brilliant moonlight nights. Ordinary tools are generally furnished by the company; otherwise he uses a sharpened bamboo stick for a pick or bar and loads the material with his hands into small baskets, which are carried on the head, or he may throw the dirt with his bare hands from pit to spoil bank. His methods and tools are of the crudest types, but he is rapidly appreciating the utility of the simpler tools. On such small section work the entire family—men, women and children—take part.

The various departments of the military have employed large numbers of natives and their published reports are in general favorable to the economical prosecution of works requiring semi-skilled and unskilled laborers as compared with similar American laborers. The comparative efficiency is reported as approximating 3 native to 1 American laborer. When laborers of other nationalities have been employed, they have been replaced with native laborers, not on account of a governmental policy, but for economical reasons.

In the past it has been difficult to secure laborers from other nearby localities on account of the then existing caciquism or the generally despotic control of a barrio by a man who arbitrarily exercised the rights of a petty king. While this condition is still in evidence, it is being rapidly overcome by American policies.

Filipino labor is in a period of transition. It needs the application of American ideas, methods, energy and supervision. The advances already made are encouraging to those actually engaged in solving the labor problem in the Philippines. That it will be successfully solved through the employment of Filipinos rather than of people from neighboring countries is not doubted by practical observers on the ground.

The Bureau of Engineering has employed thousands of laborers throughout the Islands on road and bridge work. During the past year it has been possible to extend the period between paydays from one day to two weeks, and service has been extended from a period of a few days into months. The efficiency of laborers is increasing and a knowledge of ordinary tools extending. Semi-skilled labor has been satisfactorily developed. In many localities labor gangs have been secured for work in remote municipalities or other provinces. Laborers of other nationalities have not been employed in sufficient numbers to justify a general comparison. Of the 40,000 Chinese in the Islands few are available for ordinary laborers; they come to the Islands for definite purposes, they are the pioneers of their nation, they seek to be traders and retailers, and begin in the smallest ways; they persistently retain national characteristics and methods, and avoid supervision by other nationalities. Japanese are not now available in quantities sufficiently large to meet the needs of extensive contract work.

Specific information on the efficiency of native semi-skilled and unskilled laborers has been difficult to secure. They seek clerical positions as soon as ability to read and write has been acquired. As typewriters they equal Americans when copying from a plain copy. As tracers they excel the American draftsman in neatness, and perform about one-third as much work; at present they cannot make an accurate structural drawing from a rough sketch. They are efficient when deftness of hand and patience is required, but fail when designing and forethought are necessary. They are good messengers, and after proper instructions efficient rodmen and surveymen. The principal difficulty is that they cannot be depended upon for continuous service in the field month after month. In the office, in the vicinity of their homes, regular continuous service is given, and considerable success attained in developing the educated native in the solution of the simpler problems involving logarithms.

The following tabulations have been compiled from actual records of work in the City of Manila and in the provinces, and are the averages on both Government and private works. The wages quoted apply to Manila and its immediate vicinity, and are expressed in Philippine currency.

Class of work.	Daily wage in Manila.	Aver. day's work (1 laborer).
Rock excavation (adobe)	P1.00	1.1 cu. m.
Earth excavation	1.00	2.1 cu. m.
Back filling	1.00	6.3 cu. m.
Cement curbs	1.50	2.1 lin. m.
Cement sidewalks (by hand)	1.50	1.8 sq. m.
Crushing stone (by hand)	1.00	1.1 cu. m.
Laying wooden block pavement in concrete	1.00	0.67 sq. m.
Trenching (shallow)	1.00	1.8 cu. m.
Laying pipe	1.00	4.1 m.
Unloading and storing mdse.	0.80	4.9 tons
Typesetting	2.20	3,000 ems.
Engraving	4.50	3 name plates
Bookbinding	1.00	1,000 sheets
Field riveting	0.80	125 per day
Cigarmakers, hand	....	100 per day

An analysis of these items shows that the actual cost of labor for work accomplished is in general the same as in the United States, and that the relative efficiency of native, as compared with American laborers, averages about three to one.

The following data are compiled from the records of the City of Manila and represent the averages for the work specified over a period of one year:

AVERAGE COST OF LABOR.

Street cleaning, average all kinds	P0.155 per 1,000 sq. m.
Stone block	.23 " " " "
Wooden block	.22 " " " "
Macadam	.105 " " " "
Sprinkling with cans and hose	10 " " " "
Collecting and cleaning pails	45.00 per 1,000 pails
Garbage	.48 per one ton
Incinerating garbage	.61 per one ton

For the above items eight hours constitute a day's work. The labor scale is:

American foreman	P6.00 to P7.00
Native foremen	1.20 on street cleaning
American teamsters	4.00 on pail system
Native teamsters	1.30 on col'g garbage
Native labor, unskilled	0.60 to 1.00

On new construction for the Manila Railway Co., a typical labor gang on rock excavation, after the rock had been blasted into fragments varying in size up to 4 cu. m. (5.3 cu. ft.), loaded 18 dump cars having a capacity of 4½ cu. m. in 1½ hours. The gang consisted of one American, two native foremen and 76 laborers, 60 of which were actually engaged in loading and 15 in breaking the fragments too large to lift by hand. The loading was done with shovels, the rock averaged 10 ft. from the edge of the car, and the car platform was about 5 ft. above the bottom of the pit.

The wage scale was:

American foreman	P5.00
Native foremen	1.00
Native laborers	.80

The rock handled was a soft "adobe" rock easily fractured by pick or sledge and weighing about 100 lbs. per cu. ft.

Mr. John Gibson, of the Gibson Saw & Planing Mills, submits the following statements regarding rough sawing from the log. Eight men at P1.56 per day and 25 men at P0.80 per day saw 12,000 ft. B. M. at a cost of P2.71 per M.; 3 men at P1.00 and 4 men at P.0.80 resaw 20,000 ft. B. M. at a cost of P.0.3 per M.; 1 man at P1.00 and 6 men at P0.80 plane in one day 17,000 ft. B. M. at a cost of P0.34 per M. He states that in general the cost of mill work is about the same as in the United States, but that the laborer is more satisfactory, as he is steadier and more tractable.

The period since American occupation has been fruitful with heavy problems. It has been filled with difficulties due to the abnormal conditions following active warfare and insurrection. The problems confronting Congress were new, and the theories advanced untried by any country. American motives had not been trusted by the Filipinos. Criticisms both from within and outside of our borders have been based on perverted motives rather than helpful ones. The political obstructionist has been convinced in a large measure; a fluctuating currency has been banished; radical changes in governmental and in business policies have occurred. It has been a critical period of vital importance to both of the interested countries. Neither fully understood the other. It will be impossible for such adverse conditions to exist again simultaneously. The uncertain policy of the United States has been changed to definiteness, and the future policy has been clearly stated by the statesmen who visited the Islands during the past summer, and existing laws will be amended along the lines of a clearly defined policy

whenever necessary and future laws based thereon.

The cost of living and the expenses connected with the prosecution of public works have been abnormal. The tendency toward a firmer market and reasonable profits during the present year has been marked. It may be properly concluded that ample labor material, capable of considerable development under efficient supervision, is available, and that, in general, although the prosecution of large public works in the Philippines involve several conditions not applicable to similar work in the United States, they can be accomplished with practically equal economy at the present time, and that with a more extended knowledge of existing conditions on the part of the employer, and more experience on the part of the employee, such works can be accomplished in the near future with somewhat greater economy.

SANITARY CONDITIONS AS AFFECTING CONTRACTS FOR WORKS IN THE PHILIPPINE ISLANDS.

By Major E. C. Carter,* Surgeon U. S. A.

As it seems likely that there may be a number of public works, railways in particular, begun in the Philippine Islands at an early date, it has been suggested to the writer that a few words on the sanitary conditions as they now exist in these islands might not be unacceptable to those contemplating bidding for contracts, or letting them. If the sanitary conditions are known, one element of uncertainty is eliminated, and one constant is added to those to be considered in making contracts. The insurance against loss by disease will be placed more nearly on a scientific and accurate basis. An authoritative and trustworthy statement of present conditions in the Philippines may be the more useful, as the reports brought home by the volunteers and others in 1898 to 1902, are still the main sources of information in many parts of America. More recent and more favorable reports are viewed with suspicion, as it is considered possible there may be an ulterior motive in disseminating them.

Let it be said here, once for all, that the writer has no ulterior motive, no "axe to grind." It is true he has spent three years in the Philippine Islands, engaged in endeavoring to better sanitary conditions, but he is already called to other fields of duty, and is no longer officially connected with the Philippine Government.

The statements made by volunteers and others in the period beginning 1898 and ending in 1902 or 1903, were in the main correct and just. The men were unaccustomed to the tropics; knew but little of how to take care of themselves, and in fact, rather looked down upon those who did take such care, as boys, or very young or inexperienced persons always do.

Besides, the season of 1898 was a lamentably wet one, and the men were up to their knees in mud and water much of the time. They were compelled to camp, march, cook, sleep, and in fact, to live, in the most unsanitary ways. Moreover, they were oppressed by the "heim-weh" ("nostalgia"), that ever besets certain persons when far removed from familiar surroundings, and which often is the stepping-stone to melancholia and dementia. Then, too, the clothing worn was utterly unsuited to the work to be done, and skin diseases, dysentaries, malarial fevers, and all manner of infections prevailed. Add to these things, campaigning in an unknown country, in the immediate vicinity of an ever-watchful and uncertain enemy, and it may be seen that the environment of the American army at that time was hardly physically or mentally sanitary.

These conditions continued to exist in a somewhat modified form, in 1899 and 1900, and to a less extent, in 1901. In 1901 the Plague appeared in Manila, but was speedily checked. In 1902, cholera put in its appearance and swept the islands from Aparri to Zamboanga, from the north to the south. It was accompanied with rinderpest among the cattle, surra among the horses, and when hog and chicken cholera, and the locusts joined forces to afflict the people, the country seemed to have reached the nadir of misfortune. And it had, for from that time sanitary conditions have improved, and it is the purpose of this article to lay the facts of the situation, as they now exist, before the reader.

It may be surmised that the more glowing accounts sometimes seen in print, of the excellent sanitary conditions now prevailing in the Philippines, are perhaps only a shade less misleading than those already referred to. These accounts, like the former, are based on facts and on the personal experience of individuals, who are perfectly truthful and trustworthy. The truth lies midway between the two accounts, but nearer to the hopeful than to the hopeless.

The Bureau of Health, after establishing a reasonable control of sanitary affairs in Manila, and instituting certain hygienic reforms, endeavored to accomplish the same in the provinces. But the first fact that was ascertained in regard to the provinces was that there was absolutely no accurate information obtainable in regard to their sanitary condition.

A few natives who owned estates in the provinces, and certain ecclesiastics, could give more or less trustworthy information in regard to what the sanitary conditions had been prior to 1896, but conditions, sanitary and otherwise, change so rapidly in the tropics—and unless the course of nature is interfered with, or at least guided, the change is likely to be for the worse—that what was true in 1896 may be very far from true in 1906.

Officers of the army, and others who have been engaged in traversing the provinces, or in investigating conditions therein, have not always paid close attention to sanitary conditions. And while the Bureau of Health has obtained much valuable information from all the sources above mentioned, it was realized that specially trained men should be sent out to inspect and report on the sanitary matters before any satisfactory data could be collected, on which reasonably accurate conclusions might be based.

It was also found that while the need of specially trained inspectors existed, the trained men themselves did not exist. Hence, a number of physicians (Medical Inspectors), were selected and trained, first in inspecting in the city of Manila; and after they had acquired proficiency in that work, they were sent into the provinces with written instructions in regard to the special work they were detailed to perform. Owing to the scarcity of properly trained men, to the difficulty of procuring transportation, and at times to the disturbed condition of local affairs, much time was consumed in collecting the required data, and it has taken nearly three years to inspect all the provinces.

The reports of the Inspectors furnished information in regard to the following, and some other points:

1. The sanitary condition, sanitary police, and etc.
2. The condition of the markets, stores, and etc.
3. The methods of disposing of garbage, dejecta and other matters.
4. The situation of the villages, municipalities and the character of the terrain.*
5. The water supply.
6. The prevalent diseases.
7. The mortalities from various diseases.
8. What precautions, if any, are taken against the spread of communicable diseases, when they exist.
9. What ordinances or laws, bearing on sanitary matters, are in existence, and how they are complied with.
10. The customs and habits of the people as they affect health and sanitation.
11. Diseases among cattle and other domestic animals.
12. The number of (a) lepers, (b) insane, (c) blind, in each town and municipality. Any other information which may bear on the sanitary situation is also furnished.

As each township was visited and inspected a sanitary map of the Philippines might be based on these inspections. The information thus obtained is, on the whole, fairly accurate, and the data furnished and the conclusions suggested are, in the main, trustworthy. The information in detail may be obtained from the reports of the Commissioner of Public Health for the Philippine Islands for the periods ending 31st of August, 1903; 31st of August, 1904; 31st of March, 1905, and 31st of August, 1905. But as these reports are not always at hand, a few remarks representing an epitome of the facts obtained are appended:

DISEASES WHICH ARE COMMON AND WHICH MUST BE GUARDED AGAINST.

It is true that cholera, plague, tropical ulcers, yaws, various skin diseases, smallpox, malarial fevers, amoebic and specific dysenteries, etc., have been reported in the Philippines. Cholera, however, has disappeared entirely and should not return. Plague is reduced to a minimum, and exists nowhere in the Islands save in Manila, where one or two cases a week occur during the hot weather. Tropical ulcers and yaws are readily relieved by medical and other treatment. Smallpox, of course, is guarded against by vaccination.

In fact there are, generally speaking, but two diseases about which those in the Philippines need be specially concerned: (a) Malarial fevers, and (b) dysenteries. The former prevail only in certain places and may be guarded against by (1) cleaning, draining and petrolizing wet places and by keeping no standing water uncovered anywhere on or about the premises, and by destroying, preferably with fumes of sulphur, all mosquitoes in the houses or tents. (2) By sleeping under mosquito bars, or on premises protected by wire screens. (3) By the judicious use of quinine, and the segregation of malarially infected patients in mosquito-proof houses or tents. In other words, war is waged on the malarial germ (1) while in the larvae of the anopheles, (2) while in the adult mosquito, (3) while in the blood and other organs of human beings.

Of course, in every considerable camp of laborers there should be a competent physician with a microscope to make an early diagnosis of malarial infection, and to carry out the other precautions herein mentioned.

The mortality and morbidity for malarial fevers in certain parts of these Islands are high. Under proper, though not very expensive precautions, they may be reduced to as low a figure as they are in Kentucky or Georgia.

There are two varieties of dysentery encountered in the Philippine Islands. The unusual variety is the bacillic, or specific or Shiga's dysentery. Fortunately this is not a common disease at present, and may be practically left out of consideration by contractors in considering the expenses entailed by diseases.

The more common form of dysentery is the amoebic. To this great attention has been paid by Strong, Musgrave and others, and, largely due to their work, we find as high as 95%, or more, of the cases recover. But the proper treatment of this form by physicians requires the skillful use of the microscope, for much loss of time through illness may be avoided by early diagnosis and prompt treatment.

Of course, employers of labor will be most interested in knowing how to prevent the dysenteries, rather than how to treat them; for sickness means loss of time and money. As dysentery is mainly due to drinking contaminated water or eating contaminated food, the great preventive measures are:

1. Boiling of water used for domestic purposes, whether for drinking or for washing table or culinary utensils; and
2. Having all food well cooked, and preferably eaten hot.

So far as uncooked fruits are concerned, the writer has seen no case of dysentery due to the eating of fruits whose skins are thick, when properly peeled. As most tropical fruits have such skins they need not be rejected. Uncooked vegetables and salads should be avoided.

There is, of course, some expense connected with the fight against malaria and dysentery, but

*Late Commissioner of Public Health, Manila, P. I. Present address, Ft. Leavenworth, Kansas.

*Terrain: Here used to designate surface and sub-surface of local districts as related to health conditions.—Ed.

the expense is not great and the saving in the long run is considerable.

So far as the effects of the tropical sun are concerned, not much inconvenience seems to be experienced by the laborers available in the Philippine Islands, but work may be performed in the early morning, in the late afternoon, or by the light of torches, lamps, etc., at night.

All kinds of men come to these Islands for work, and the most various sorts of food are used. Major Kennon, who has just completed the magnificent Benguet road, and who had in his employ Russians, Chinese, Japanese, East Indians, Turks, Southern Europeans and representatives of the numerous peoples of these Islands, organized a most satisfactory commissary.

It will be seen, then, that from a sanitary point of view there are but two comparatively new conditions to be met in the Philippines:

1. The prevalence of malaria;
2. The prevalence of dysentery;

and that both diseases may be prevented.

STEEL SHEET PILING.

In all construction work which requires excavation in water-bearing strata, or the shutting off of a flow of water in such strata, sheet piling is a very necessary and important feature. In fact, the safety, cost and successful completion of the work, as well as the rate of progress, very often depend largely upon the efficiency of the sheet piling. The use of timber for this purpose is as old as engineering; for light work, ordinary planks may be used, but where the work is important, and water or quicksand is encountered, tongued and grooved sheeting is generally used, such as the Wakefield sheet piling. The use of canvas in connection with sheet piling was described in our issue of March 30, 1905.

Metal sheet piling has been used to a limited extent for a long time, but within the past few years it has had a somewhat remarkable development in this country, and has now become well established as an important and valuable tool for the engineer and contractor. The metal sheet piles used abroad have been usually of cast iron, with grooved and tongued interlocking joints. Such piles were used in some of the dock works of the Manchester Ship Canal and for two dams on the river Nile (Engineering News, Sept. 15, 1904). The various forms of metal sheet piles which have been used in this country within the past four or five years are all of rolled steel, either single rolled shapes or built up of structural shapes and plates. They are driven by steam-hammer or drop-hammer pile drivers in the usual way, but sometimes with a cap to prevent injury to the head. This sheeting has been used for retaining walls, cofferdams, the lining of shafts in quicksand, and for sheeting to prevent the flow of water under dams built on gravel foundation. Several forms of steel piling have been described in our columns,* and in all of these the piles have some adaptation of a groove and tongue joint so that the finished line of piles forms a solid and continuous wall. The joints may be made watertight by packing the open part with mud or dirt, or by driving wooden calking strips into them. Cement grout was used for this purpose at the Nile dams above mentioned. Experience shows that the piling may readily be made watertight, and that it is strong and reliable. In many cases where the piling is for temporary purposes, as at cofferdams, the piles can be pulled up when the work is completed, and are in condition to be used over again. In view of the rapid development and the wide and varied application of steel sheet piling, it will be of interest to refer to some of the works in which it has been used.

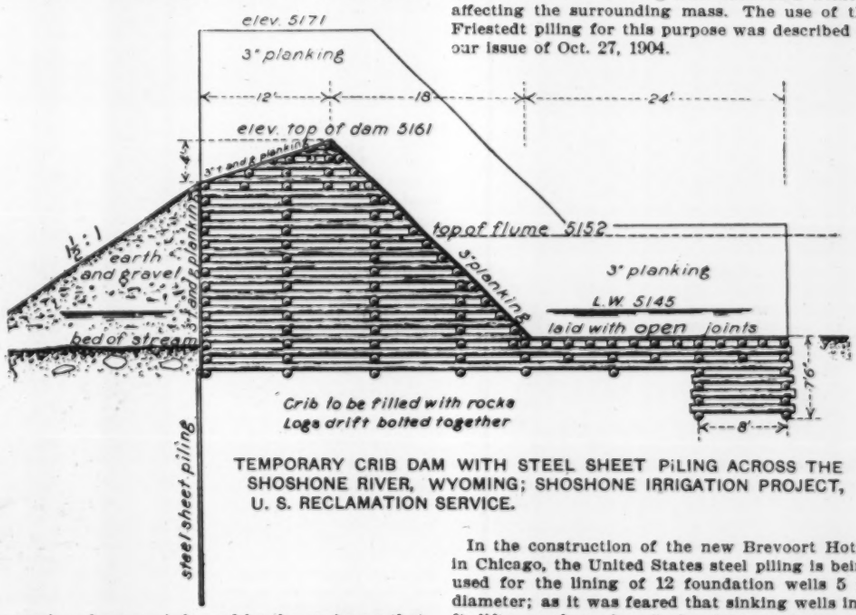
In the recent work of replacing an old single track bridge with a new double track bridge to carry the Wabash Ry. over the Huron River at French Landing, Mich., a new pier was built in a cofferdam formed of the United States steel piling; the use of steel was adopted by the contractor on account of the swift current of the river, where the water is about 12 ft. deep, and the piling had to be driven about 8 ft. into the stiff blue clay of the river bed in order to get a firm foundation. The Jackson steel piling was used for the cofferdams of the two abutments of the new bridge over the Chicago River at Randolph St., and the Friestedt steel piling for similar cofferdams for the bridges over the same river at Loomis St. and Deering St. The Friestedt piling was also used in the construction of the foundations for the Cuivre River bridge for the Chicago, Burlington & Quincy Ry. at Moscow Mills, Mo. Here 26 ft. of gravel had to be penetrated to reach solid rock, and the engineer reported that without the use of steel piling the piers could only have been founded on rock by the adoption of the pneumatic process. These cofferdams were 21 × 38 ft., and 32 ft. deep.

The use of steel piling in sinking mine shafts through quicksand has been adopted in a number of cases. In one case, two new shafts sunk in the usual way collapsed at a depth of 15 or 16 ft., owing to quicksand, but a third was successfully completed by excavating to a depth of 10 or 12 ft. in the gravel and then driving 20-ft. steel piling (Friestedt system) to the slate rock, 30 ft. below the surface; this lining proved tight and stable, and entered into the rock sufficiently to make a good joint. The shaft was then carried down through the rock in the usual way.

A proposed dam having a core wall of steel sheet piling was illustrated in our issue of Sept. 22, 1904, but in several cases steel piling has been used to prevent the flow of water beneath the base of a dam. The Hackensack Water Co. has recently completed at Hillsdale Manor, N. J., a large earth dam across the valley of a stream, having a concrete core wall 1,500 ft. long built upon the top of a line of Friestedt steel piling, which is driven 40 ft. to bed rock to prevent percolation of water beneath the dam. Steel piling has already been used in some of the irrigation works of the Reclamation Service (U. S. Geological Survey), and seems likely to be used very extensively in works of this kind. The diversion dam in the Truckee River, California, for the Truckee-Carson irrigation project, has beneath it a line of Friestedt steel piling to cut off the underflow. The river bed consists mainly of boulders and gravel, and we are informed by the engineers that it was very difficult to sink the piles; in fact, that wooden piling could not have been driven. The steel piling was somewhat battered and bent, and the resulting wall was crooked, but the results were very satisfactory. The United States steel piling has also received favorable comments from several engineers in the Reclamation Service, but as a rule no particular form is specified, the selection being left to the contractor, subject to the engineer's approval. In the accompanying cut is shown a cross section of a temporary dam which it is intended to construct on the Shoshone River, in Wyoming, for the purpose of diverting the river during the construction of the dam for the Shoshone irrigation project. A line of steel sheet piling is to be driven along the up-stream face of the dam, to cut off the underflow, and it is expected that this will be withdrawn after it has served its purpose. As the work is temporary, the design of the dam and the style of sheet piling are not specified by the engineers, the drawing being only a suggestion, and the contractor being required to submit his own design for approval, but it is stated that anything which would form a steel diaphragm across the sub-channel of the stream would be satisfactory to the Reclamation Service in this case. In repairing the Amity dam of the Arkansas Valley Sugar Beet & Irrigated Land Co., Lamar, Colo., a cofferdam was built of United States steel piling. Here the piles were driven through clay and gravel and also through buried logs, but the engineer was well satisfied with the results.

In a dam for the Apple River Power Co., at Riverdale, Wis., a line of sheet piling formed of old steel rails was driven beneath the base of the dam. These, however, were only 5 ft. long, with an effective depth of 4 ft., about 12 ins. of the top being embedded in the concrete of the dam. (Engineering News, Oct. 12, 1905).

Steel piling is also being used in foundations for buildings. In the construction of large buildings in Chicago, deep foundations are now very extensively used, as described in our issue of Dec. 22, 1904. These foundations consist of concrete piers sunk through the overlying bed of clay to hardpan or solid rock. The method of construction consists in sinking open wells through the clay and then filling these with concrete. Where the clay is firm, the wells are usually excavated in 5 ft. lifts and are lined with 5-ft. grooved and tongued vertical wooden staves braced by interior hoops of steel. In soft clay and in quicksand, however, special means are required to pass through the unstable material, and the use of rings of steel plates forced down by jacks has been successfully practiced in some cases, as described in the article noted above. Another method is to drive metal sheeting to form a caisson of any desired shape, the material inside being then excavated without affecting the surrounding mass. The use of the Friestedt piling for this purpose was described in our issue of Oct. 27, 1904.

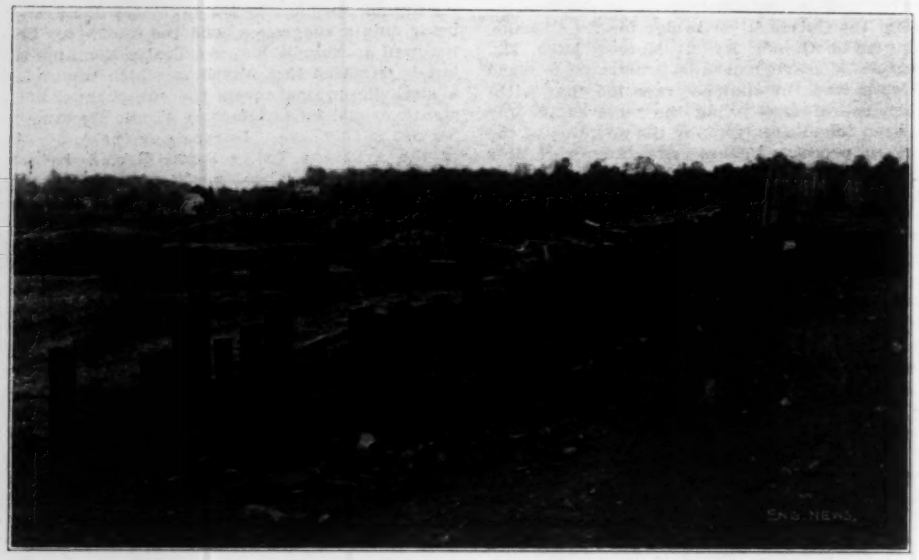


TEMPORARY CRIB DAM WITH STEEL SHEET PILING ACROSS THE SHOSHONE RIVER, WYOMING; SHOSHONE IRRIGATION PROJECT, U. S. RECLAMATION SERVICE.

In the construction of the new Brevoort Hotel, in Chicago, the United States steel piling is being used for the lining of 12 foundation wells 5 ft. diameter; as it was feared that sinking wells in 5 ft. lifts, as above described, might result in some movement of the clay body before the lining could be placed, thus endangering the foundations of the adjoining buildings. The piles are driven to a depth of 30 ft., reaching firm bottom. To ensure accuracy, at each shaft a complete circle of 5-ft. lengths of the steel piles was first driven. One of these short piles was then pulled out, and a 30-ft. pile set in its place and driven home; this operation was continued until a complete cylindrical caisson was formed by the 30-ft. piles. The clay was then excavated from the inside, and the

*Jackson system: Interlocking Steel Sheeting Co., Chicago; Feb. 14, 1901, and March 5, 1903. Friestedt system: Friestedt Interlocking Channel Bar Co., Chicago; June 11, 1903; Oct. 27, 1904. Wittekind system: Wittekind Interlocking Sheet Piling Co., Chicago; Sept. 10, 1903. United States system: United States Steel Piling Co., Chicago; Sept. 29, 1904. Construction of cofferdams, Aug. 10, 1905.

well filled with concrete. The 5-ft. lengths were afterwards used to form caissons in combination with longer piles, the short pieces being at the top and bottom of alternate piles. The same steel piling was also used for a retaining wall along the west side of the site. It has also been recently used for sheeting the foundations of the new extension of the Tribune Building at New York, these foundations being sunk below the level of the footings of the old part of the building.



SITE OF HILLSDALE RESERVOIR DAM, SHOWING TOPS OF INTERLOCKING STEEL SHEET PILING BEFORE BUILDING CONCRETE CORE-WALLS.

These precedents are of particular interest in view of the proposal to use steel sheet piling beneath some of the great dams for the Panama Canal in order to cut off the underflow through permeable strata beneath the dam, as described by Major Cassius P. Gillette in our issue of July 27.

STEEL SHEET PILING IN THE HILLSDALE RESERVOIR DAM, HACKENSACK WATER CO.

The first instance in the East of the use of steel sheet piling in dam construction, it is said, was beneath the concrete core wall of the earth dam forming the Hillsdale Reservoir of the Hackensack Water Co. The last of the piling named was driven in July, 1904. The company supplies Hoboken and some thirty-five other New Jersey suburbs of New York with water from the Hackensack River. The company had a storage of practically 100,000,000 gallons at the distributing reservoir end of its pipe system, but had no storage facilities on the river end of its long pumping mains. As the consumption was geting too near the dry weather flow of the stream, a storage reservoir across Pascack Brook, a tributary of the Hackensack, was put under construction in 1904 and put in use early in 1905. The reservoir has a capacity of 830,000,000 gallons. It was formed by throwing a dam some 1,500 ft. long and 35 to 38 ft. high across the stream named. The embankment is composed of earth in 6-in. layers. It is 24 ft. wide on top and has slopes of 2 to 1. The inner slope is paved with 18-in. stone. The water line is 5 ft. below the top of the dam.

The concrete core wall is 18 ins. thick at the top, has a batter of 1 in 16 on each side, and is carried but slightly below the original surface of the ground.

The material at the site proved to be anything but favorable for dam construction, being made up entirely of coarse gravel and boulders, through which much water naturally flows. Below this material there is a rough bed of sandstone rock. To have undertaken to get borings across the valley where the dam was to be located would have publicly revealed the intentions of the water company before the property which would be flooded had been secured. It was, therefore, decided to obtain the property before any further move was made. As timber sheeting could not be driven in such material it was decided to use the Friestedt interlocking steel sheeting (see Eng. News, June 11, 1903, and Oct. 27, 1904). Water jets were used to aid in driving the sheeting, the heads of which were protected by caps. The length of the sheeting at various points ranged from 20 to 40 ft. The plans called for the sheeting to extend 4 ft. into the concrete, but no attempt was made to leave the tops on an even line.

The sheeting was completed in July, 1904, and the reservoir was put in use in the spring of 1905. The leakage of the dam, according to recent weir measurements, amounts to only about 500,000 gallons a day, most of which doubtless passes through the gravel stratum underneath the feet of the sheet piling. This result is considered very satisfactory, in view of the gravel in which most of the sheeting terminates and which forms the bed of much of the reservoir.

The dam was constructed on a percentage basis by Mr. Myles Tierney, President of the Hudson Trust Co., Newark and Hudson Sts., Hoboken, N. J. Messrs. Hering & Fuller, 170 Broadway, New York City, were consulting engineers for the work. They suggested the Hillsdale storage reservoir, designed the dam and recommended the interlocking sheet piling. Mr. Wm. B. Fuller was engineer-in-charge. Mr. D. W. French is superintendent of the Hackensack Water Co., Weehawken, N. J. We are indebted to Mr. Tierney for the foregoing information.

THE BERLIN ELECTRIC Rapid Transit Railway (elevated and underground) will probably be extended in a short time by a branch line north through the center of the city. Application for a franchise for the extension has been made to the city authorities by the company, and has been approved in committee. The existing line (Eng. News, May 15, 1902) runs generally east and west through the southern half of the city. The proposed extension leaves this line at about its middle, and runs north and east in subway, crosses under the Spree by tunnel, and continues in subway northerly to the Schönhauser Allee Station of the Ringbahn. Such an extension was planned at the time the road was built, and a short spur from the main line to the Potsdam Depot was built as part of the original work; the new work will continue from the Potsdam Depot station.

THE MANUFACTURE OF CONCRETE BLOCKS AND THEIR USE IN BUILDING CONSTRUCTION

(Extracts from Papers Submitted in Engineering News Competition, and Not Receiving Prizes.)

IV.

Besides the two papers awarded prizes in Engineering News Competition, there were received ten others, nearly all of which contained contributions of value to the knowledge of the subject of concrete block manufacture and use. From these ten papers we have selected extracts, and arranged them under descriptive headings for publication. The method of presentation adopted as most nearly fair to all is to give the author's name in each case, and follow it with the extracts selected in as nearly as possible the author's own words. When two or more authors have presented the same fact, that author's presentation which seemed to us best, judged by the rules under which the competition was held has been chosen.

The names and addresses of the authors from whose papers extracts have been taken are as follows: Joseph Babiczky, Guardian Trust Building, Kansas City, Mo.; Geo. H. Crafts, Box 245, Atlanta, Ga.; H. H. Frantz, 3021 West Grand Ave., Des Moines, Ia.; U. G. Hayne, Fort Stevens, Ore.; Noyes F. Palmer, 150 Snediker Ave., Brooklyn, N. Y.; H. H. Rice, 381 South Logan Ave., Denver, Colo.; H. G. Richey, Superintendent, U. S. Public Buildings, Evanston, Wyo.; G. W. Robertson, 107 Walnut St., Marion, O., and G. W. Stevens, 15 Warrenton St., Boston, Mass.

The subjects considered in this article, which is the concluding article of the series, and the remarks under each are as follows:

WATERPROOFING.

U. G. HAYNE.—There are localities where waterproof walls are very essential, while other places where the rainfall is very small have very little need of such a wall. Where one is required, good results can be obtained from a waterproofing mixture of alum, lye and cement, to be used as a wash, and made of the following proportions:

Dissolve 1 lb. of concentrated lye and 5 lbs. of alum in two gallons of water, care being taken to have every particle dissolved. Heating to near the boiling point will quickly insure this without injury to the mixture. This constitutes the "stock" and may be mixed in any quantity. To one pint of the stock add 10 lbs. of cement, thinning out with water until the mixture spreads easily and well on the blocks or walls with a calsomine or whitewash brush, filling all the pores in the face of the block. This is satisfactorily done when it lathers freely under the brush. Usually, one pint of the stock put into a 12-qt. pail and 10 lbs. of cement stirred in, with enough water added to well fill the bucket, makes the wash about right.

CONCRETE CORE-WALL FOR HILLSDALE RESERVOIR DAM, NEARLY COMPLETED.

Much depends, however, upon the condition of the surfaces to be coated, as to how dry they are

to be dry, wet them down with a spray or a hose ahead of the waterproofing, the object being to apply the wash as thin as practicable without foaming, rubbing the wash well into the block with the brush. The wash should be applied to that face of the block that is to be exposed in the wall three or four days after it has been made, and while the block is being kept wet in curing, as a few hours are sufficient for the wash to harden enough to stand a spray. The wash is not satisfactory on old work and should be applied while the block is under cover from the sun and while it is moist. Otherwise too rapid evaporation of the water in the wash will leave the cement without the necessary moisture to set it and hardening it so it can be brushed off. The wash should never be applied too thick or it will be liable to scale off similar to paint that is applied too thick.

One part "stock" and about thirty parts water can be used for wetting the one part cement to two parts sand mixture that the blocks are faced with, instead of using water, with good results. This will leave the face of the block as it comes from the mold without the mark of a brush on it.

I have seen this wash used for over twelve years and in no instance, where it has been applied correctly, has it failed to make the surface waterproof. In fortification work I have seen sand fills sluiced over the top of concrete surfaces under which were rooms and passages, and the water stood for weeks above them without a sign of any of it coming through. Have used it on cable tanks with complete success. Two tanks constructed seven years ago, and made to hold 6 ft. of water, have been in use continually since that time and lose no water except by evaporation. In this case two coats of the wash was applied to the inside and bottom of the tanks, and also to the outside walls. The concrete was first plastered with a coat of one part cement to two parts of sand, mortar.

A large store house constructed eight years ago, with solid walls 1 ft. thick, in a climate where the annual rainfall is about 80 ins., was given two coats of the wash under the same condition as the cable tanks, and it has been dry at all seasons since, with no sign of moisture on the walls. In addition to its waterproofing properties this wash tends to prevent fungus growth on, or discoloration of surfaces coated with it. It thoroughly closes the pores of the plaster and insures dry walls.

A block faced with a mixture of one part Portland cement to two parts clean sand, well tamped, is nearly waterproof and if correctly cured will answer in many localities without waterproofing. The facing on a correctly made block is in no danger of peeling off.

The Sylvester process leaves the surface of the concrete looking practically the same as when taken from the molds, and in some instances this is much to be desired. The method of mixing and using which is as follows: Dissolve 1½ lbs. of castile soap in 1 gal. of water; also dissolve 1½ lbs. powdered alum in 4 gals. of water, when the surface is dry apply the soap wash at boiling heat with a brush, but do not froth the soap. After the soap wash is thoroughly dry apply the alum wash the same way at a temperature of 70° F. The applications should be made twice to secure perfect impenetrability to water.

The alum and lye wash sprinkled, immediately after applying, with granite dust, or, in fact, with any very fine sand or stone dust, will make the block look very much like natural stone, though I do not see any very good reason why concrete should not be able to pass on its own good looks if dressed up as it should and can be.

A wall can be painted with an ordinary linseed oil paint and made waterproof for a time the same as a brick wall is sometimes painted, only the paint should not be applied for at least six months after wall is made, as the paint will not stick sooner. Would not make a custom of painting block walls.

COST.

U. G. HAYNE.—As the cost of the materials vary with each locality, it will be necessary to assume prices at which materials and labor can be purchased, and which can be easily adjusted to suit the location. The prices here given are all higher than in most parts of the country, but prevail in this vicinity. Cement, $2.50 per barrel of about 3.4 cu. ft., or 4 cu. ft. measured loose; sand, $1 per cu. yd.; labor, $2.00 per day of nine hours. That incidental expenses will amount to about 4% of the total cost of the blocks, which is about right for a small plant, but a little high for a large one.

The cost of the blocks that will lay the same amount of wall as 1,000 ordinary sized building brick, is about $7. This is calculated with a one part cement to four parts sand mixture, and figuring out 25% for the hollow spaces. Any other mixture can be figured out with this as a base. For laying blocks of about one to two cubic feet volume, it takes about one-fourth the mortar and about one-third the labor, that it takes to lay the same space with brick. The cost of special blocks, to comply with the requirements of the plans, will vary according to the difficulty of making them, or from two to four times as much as for ordinary blocks.

I understand that in some cities the building ordinances permit a hollow block wall to be somewhat narrower than a brick wall would be required for the same place. When in considering the cost of a block, it must be remembered that there is practically no difference in the cost of a plain, panel or rock faced block, and that there is considerable difference in the cost of brick, pressed brick and stone.

At the figures given above, a 12 in. wide, by 24 ins. long, by 8 in. high, block will cost 19 cts.

JOSEPH BABICZKY.—The cost of manufacturing blocks varies very much in different localities, but can be calculated near enough before anybody goes into the business of manufacturing blocks. My experience is that one part cement and five parts sand properly mixed, tamped, handled and cured gives as good blocks as any common building stone. Or if suitable crushed stone can be obtained then 1 part cement, 3½ parts sand and 6 parts stone is also a good mixture, supposing that the sand is not too coarse and the crushed stone has a maximum size of ½-in. down to dust. I will give examples of how to calculate the cost of manufacturing. Suppose a small plant started with four hand machines.

With four machines 400 blocks can be handled daily. The blocks are supposed to have the following dimensions: 24 x 8 x 8 ins., and contains, after deducting the hollow spaces, ½ cu. ft. of concrete.

Mixture: 1 part cement and 5 parts sand; necessary for 1 cu. yd. of concrete, supposing that a barrel of cement = 3.5 cu. ft.

Cement 27/5 : 3.5 = ...1.54 barrels
Sand ....1 cu. yd.

Total expenses for 400 blocks daily capacity by using 400 x 0.5 = 200 cu. ft. = 7.4 cu. yds. concrete are:

Materials:		
Cement	1.54 × 7.4 × $1.8 =	$20.50
Sand	7.4 cu. yds. at 60 cts. =	4.44
Labor:		
4 molders	at $2.00 =	8.00
2 mixers	at 1.50 =	3.00
1 water boy	at 1.00 =	1.00
Total		$36.94

or $\frac{36.94}{400}$ = $0.925 per block.

To this must be added the interests of the capital invested, maintenance of the machinery, tools, etc, office expenses, etc. This will make the average price about 10% per block.

BUILDING CONSTRUCTION.

N. F. PALMER.—The laying of concrete blocks is the duty of a stone mason, and calls for the same mortars and methods as with a stone or marble building, except that in the stone or marble structure the cutter and trimmer under the scaffold does the preparatory work, from measurements from the wall, while the concrete blocks come to the scaffold the exact size. A concrete block cannot be cut and fitted to the wall—at least not on the outside—without breaking the skin or outside set without opening the entire inside of the block to moisture and dampness—the enemy of all stone buildings. Therefore, the problem for the mason is to lay concrete blocks so that the outside can be pointed up tight and true.

Foundations should not be made with either mortar blocks nor with brick. Brick foundations, unless treated on the outside, will always create dampness which will permeate the entire superstructure, whether of wood, stone, mortar block or iron. Concrete blocks can be used as foundations, but should be treated on the outside to prevent dampness, and the hollow spaces ventilated. Regular concrete of 1-3-5 in the usual forms are cheaper than molded blocks of any material for foundations. We have seen foundations holding up four-story brick buildings, made 1-3-5, and the 5 was gravel, not a broken stone in it. We should have preferred broken stone to round gravel. The best Portland cement should always be used in foundation work, no matter if of stone, brick or concrete in any form, but never use hollow mortar blocks in foundations.

Preparatory to the mason's work it is presumed that the architect's details have called for such units in the wall, and fractions to fit all corners, openings and stretchers as will fit the plan. Corner blocks are laid first and from the center both ways the marks are made on the foundation by the use of a gage showing the unit, its half, three-quarter and one-eighth size, etc. No blocks are to be laid on a course until this marking agrees with the plan. Mortar should never be spread within one inch of the outside of a finished wall, or in the center line of the block lengthwise of the wall. The outside one inch for pointing up, the center line to permit of longitudinal circulation of air to allow circulation of damp air from the damp side of a building around to the drier side. In pointing up the best Portland cement putty with stone dust, and a small percentage of hydrated lime should be used. In our experience we have seen several concrete block buildings faced with La Farge cement that had the dry appearance on all sides of the structure, because of this method of mason work. In that case, of course, the blocks were faced in the manufacture of the block, and were pointed up after completion. It is well known that La Farge cement is for inside fine finish, and the use of it on the outside of a building was an innovation. To our mind the skill of the mason builder and of the architect on this concrete block building is manifest. On the contrary, we have seen buildings erected under charge of this same architect and mason builder who failed to build a satisfactory structure in this same neighborhood with blocks that were not faced, that were cut to fit the wall, where double the number of blocks were made and half the blocks condemned as unfit, mistakes of the block machine man and lack of knowledge how to plan and how to build. The fact that the same architect and mason builder tried again with a different machine and erected an $8,000 Queen Anne building and sold it as soon as completed, is proof that the industry only lacks skill of architect and builder.

Now what can be done to a completed building made with mortar or concrete blocks to improve its appearance, or to remedy defects of face mix? Nothing can be done in such building to correct the unequal mortar joints caused by improper size blocks. The joints may be repointed, and the face may be recoated, which will improve the structure. And the manner of doing this can also be followed where the material was first-class as well as the mason's work, by a wash coat of Portland cement and hydrated lime. We have tried this, as well as a wash coat of alum water, followed with soap water. The later method can be done, and then a wash coat of Portland cement and hydrated lime. We have tried this on blocks we know were poorly made, merely to show operation of our machine, and we are satisfied that any concrete block building can be treated and made more impervious and of uniform exterior, by a wash coat of 1 Portland cement, ¼ of hydrated lime used as a whitewash. In fact, we have treated chimneys exposed to great changes in temperature, and, in fact, leaky tin roofs, in same manner and are surprised at the result. We give these experiments as the result of practical experience, and in block construction it is well to bring some of these practical experiments to bear in this new industry.

GEO. H. CRAFTS.—It is a great mistake for a building block manufacturer to try to compete with common clay, brick or wood construction in

price, as to do it he has to make an inferior article which will eventually injure him and the business. Good blocks cannot be made as cheap as common bricks in most localities and there is no use in competing in price with them. Concrete building blocks do not compete with common bricks, but with natural stones and pressed bricks, and where these materials are cheaper than good building blocks there is no need of a building block plant and it cannot be made a success. This will happen in very few, if any, localities, however, as the cost of quarrying and cutting and laying of natural stones is much more than the cost of making and laying building blocks. The qualities of good concrete blocks will often give it the preference over pressed brick or terra cottta at about the same prices.

JOSEPH BABICZKY.—Most walls are constructed not only for direct vertical loads, but also to resist the lateral forces which act, if walls are high in comparison with their width. The ideal wall is the monolith concrete wall, and the weakest in construction are the walls built out of brick, as the many horizontal and vertical joints of a brick wall are the weak points in every respect, no matter how carefully built and bonded. The hollow concrete block wall has the advantages of both, without having their disadvantages, as it is almost a monolith as usually laid in first class cement mortar. The face is uniform, can be made in any color or finish and also with architectural design. Offers can be made for building a house per square foot, but before starting the manufacturing of the blocks extra drawings must be prepared showing every block in the building. Then an index must be made, which shows the different sizes and the number of blocks.

The first thing is to prepare such plans. The architect (if any is engaged) lays out the plans for brick or frame building and his plans must be worked over for cement blocks. It is very simple work, notwithstanding it must be done very carefully. Every phase of manufacturing and also using of cement blocks must be taken into consideration in making advantageous and acceptable plans for this purpose. If possible, whole, three-quarter and one-half blocks must be used, and the use of different sized blocks makes the manufacturing of the concrete blocks complicated, and also building walls out of them, causing extra expenses. Corners, pilasters, etc., must be shown not only in view, but also in plan. The working drawings for the masons must be made clear and easy to read, as otherwise misunderstandings and delay in the work may easily result.

It happened in my practice, that everything was in first class shape, but I could not get any masons, who could lay concrete blocks easily and with a fair amount of speed. I was obliged to watch them and not only see that the blocks were laid after the working drawings, but that the wall went up straight, joints pointed up before the cement mortar hardened. Brick masons are not suitable for cement block setting, and they are too high priced, too speedy and are not accustomed to lifting heavy weights and to do exact work. First class stone masons are required, but they must also be very closely watched.

My opinion is, that every block manufacturing plant must have not only the special workmen for the manufacturing of concrete blocks, but also those who build them in the wall. The organization of the concrete block manufacturers or the entire business world which is especially connected with using of cement for the different purposes, must take place without any delay. This is such an important branch now, and it develops with such immense rapidity, that an immediate organization of the partakers is indispensable. To protect trade, labor, and to guard the reputation of such an important business branch by a well organized body, is absolutely necessary.

Now, often different unions make trouble. The brick masons are of the opinion that the wall out of concrete blocks can only be built by them, the stone masons are of the same opinion, and I think neither of these unions have the right to "butt in," and the reason why they do is that they do not have to confront a strongly organized cement working union.

Concrete blocks must be laid in good Portland cement mortar, 1 part cement and ¼ slacked lime, and 3½ parts sand. First, cement and sand must be mixed dry thoroughly, then slacked lime added.

My experience has been that in summer often cement mortar is half set when the last third part of the batch is used up. The mortar mixers must be instructed and also watched very carefully, as they are mostly accustomed to lime-mortar, which can be used even after days have elapsed without any disadvantage. Let them make small batches and mix thoroughly dry, and after that wet same.

If late in autumn or early in spring, walls must be built out of concrete blocks, it is better to leave slacked lime out entirely, and use one part cement and three parts sand, as the night frost may destroy the cohesion of the cement mortar if it is not yet set. In hot summer days the blocks must be sprinkled over before set in the wall and the mortar made good and slushy, as otherwise the cement mortar will dry out before it hardens.

Avoid if possible any kind of work with cement in winter time. If unavoidable, be very careful. Never do any work under 25° above zero. Under 40° above zero the manufacturing plant must be heated. Be careful and do not use an open coke stove when you are working in a tent, as the gases which develop destroy the top of your tent in a short time. If the temperature is less than 32° above zero, the sand and the water must be heated for the block and also for the mortar. The frost alone does not injure even fresh cement concrete very much, but the alternating of frost and thawing loosen the cohesion and lessens the strength considerably.

I made an interesting experiment on this point last winter, when I was obliged to complete a very important structure as soon as possible. It happened that at noon the thermometer showed 40° above zero and the next morning 10° below. My blocks, notwithstanding I had a big stove fired night and day, on the north side were frozen bone hard, and they were covered by hoar frost. I broke off about one-fourth of a block and wrapped it in a paper and placed it in the drawer in my room. I thought that one frost, no matter how strong it was, could not destroy the hardening capacity, but only stop the process, as the frozen water is a solid substance by which the hardening process is only stopped. Thus my opinion was proved after three or four days, as the soft and brittle piece of the concrete block thawed out and the hardening process completed satisfactorily, but the wrapping paper was thoroughly soaked with water. I remarked before that the blocks on the north side of the tent were covered with hoar frost. This happened because the blocks are better conductors of heat than the air, and so the moisture of the air precipitated on the blocks forming, after the temperature went under the freezing point, hoar frost on them. After thawed out this precipitated moisture furnished extra moisture for the blocks which helped the cement to perfect crystalization, but, indeed, in my case, wet also the wrapping, which was a sign that water was at present in abundance.

These blocks were made out of a dry mixture which is absolutely necessary in winter time. As when the water passes over a certain percentage even so by the first freezing the cohesion will be entirely destructed, which I observed in different cases, when soft concrete was poured in forms building up walls. So far the frost penetrated the concrete became entirely loose, and could be brushed off with even a soft brush.

Cost of the complete wall.

The costs of the complete wall are composed:
(1) Concrete blocks on the ground.
(2) Cost of materials for mortar.
(3) Labor.
(4) Staging.

I will show in the following a general example how to calculate the costs of the complete wall:

(1) Concrete block 24 × 8 × 8 ins. in the factory.. 10c.
Handling and hauling to the place where the building has to be erected, average ..... 2c.
Total costs = ... 12c.

(2) Mortar: 1 cement and 3 sand.
For 100 blocks are necessary about 9 cu. ft. mortar.
Cement $\frac{9}{3} : 3.6 = 0.834$ barrel @ $1.80 = $1.50
Sand $\frac{9}{27} = 0.333$ @ .60 = .20
Total $1.70
also per block 1.7.

A mason can lay on an average of 10 blocks in one hour, including pointing, so $\frac{40c.}{10} = 4c.$ per block.

Now suppose a gang of five masons working on the place 8 hours each = 40 hours, making 10 blocks an hour = 400 blocks. These 400 blocks having the dimensions of 24″ × 8″ × 8″, will cover 530 sq. ft. The total cost of the 530 sq. ft. wall will be:

	400 concrete blocks at 12c.	= $ [illegible]
Mortar	400 × 1.7c.	= [illegible]
Masons	400 blocks at 4c.	= [illegible]
Helpers:	1 mortar mixer.	
	1 " carrier.	
	3 block carriers.	
	2 pulling up mortar and blocks.	
Total:	7 helpers at 8 hours = 56 hours, at 18c.	= [illegible]
	1 foreman	= [illegible]
Staging	made out, barrel or horses, material and handling	2.00
	Total	$[illegible]

8692c. = 16.4 per sq. ft.
530 sq. ft.
Profit 25% 4.1c.
Total 20.5c. per sq. ft. complete wall, made out of complete blocks.

Concrete wall of 8 in. is at least as good as brick wall 13 in., as the blocks are at least as strong as any brick of middle quality and laid in cement mortar, concrete blocks make almost a monolithic wall.

By comparing a concrete block wall with a wall made out of bricks, it must be supposed that pressed face-bricks were applied, 7 pieces to the square foot, and backed with common red brick. The 13-in. wall contains per sq. ft. 21 bricks. The cost of the ready brick wall is composed as follows:

7 pressed face bricks @ $30.00 per 1,000, ready in wall	= 21c.
14 common red brick @ $10.00 per 1,000, ready in wall	= 14c.
Total	35c.

PROGRESS ON THE PANAMA CANAL WORK.

In our issue of Nov. 9 we printed an address of Mr. T. P. Shonts, Chairman of the Panama Canal Commission, summarizing the status of work on the canal. On Nov. 18, before the St. Louis Commercial Club, Hon. Wm. H. Taft, Secretary of War, who has just returned from a visit to the canal work, delivered a very interesting address, too long, however, for full publication in these columns. In what follows, therefore, we have omitted such matter as is already familiar to most of our readers, and have given chief space to Secretary Taft's frank statements concerning the troubles and difficulties experienced in the past two years, as to which hitherto little or nothing official and authoritative has been available.

I begin my history with the discussion in Congress as to the preferred route for a canal to connect the Atlantic and Pacific oceans. Other things being equal of course the best route is the shortest, and that is neither Nicaragua nor Panama. The shortest route, not more than 30 miles, is across the Isthmus of Darien, by way of the San Blas River, 30 miles from tidewater to tidewater. The difficulty with this route is that it requires the tunneling of a mountain 1,500 ft. high in such a way as to permit the passage of modern steamships. The length of the tunnel is more than 5 miles and at least 150 ft. in height above the water. Modern engineering has as yet accomplished no feat equal to the arching of such a tunnel, and the best evidence seems to show that the interior of the mountain is not granite or some hard rock that would hold itself in place after tunneling, but is probably a shaly or volcanic substance requiring the roof of the tunnel to be supported. The Nicaragua route, which had and still has sincere and strenuous advocates, is much longer, being about 137 miles in length, and involves the extensive dredging and use of a lake some 110 ft. above sea level.

The Panama route was but 46 miles in length from shore line to shore line, had been partly constructed, and was paralleled by an existing railroad, an agency indispensable to constructing any canal. The routes were all thoroughly discussed by the Walker Commission, and it finally recommended the Panama route. Congress by a majority vote deliberately reached the same conclusion, and confirmed it in the so-called Spooner Act passed early in 1902.

The decision of Congress in favor of this route for a canal was undoubtedly a wise one. Few engineers who have visited the canal have doubted the possibility of its construction, either as a lock or as a sea-level canal, and the Walker Commission, when it found that the Panama Canal could be bought, in changing its views,

if it did change them, from a recommendation of the Nicaragua Canal to that of the Panama Canal, instead of subjecting that body to criticism entitled it to the gratitude of the nation. Under the Spooner Act, the President bought the Panama Canal from the New French Panama Canal Co. for $40,000,000. That which he bought consisted of a canal at sea level, constructed 40 miles from Panama to Bohio on the Atlantic side, and 5 miles at the same level from La Boca to Miraflores on the Pacific side. These two stretches were dug in accordance with the specifications for the old canal, and have been filled with water for twenty years. They have been filled at places with silt and other material, so that they will need redredging. Furthermore, as they were only 28 ft. deep, as originally planned, and so not furnishing draft enough for the largest modern steamships, their depth must be increased to 35 or 40 ft.

I ought to say in passing that, contrary to the expectations of the engineers, the prism of the canal at sea level in these two stretches, completely dug twenty years ago, both on the Atlantic and the Pacific sides, has been remarkably well preserved. The banks are as firm and have the same slope as given originally, and the amount of silt and other deposit from the Chagres and other rivers flowing into and through it has proven to be comparatively small.

It is very doubtful how much of the French machinery, material and equipment can be used. Mr. Wallace, the former engineer, was of the opinion that he could use most of the locomotives and a great many of the flat cars, and spent a considerable sum and much time last year in repairing the best of them. I believe that the consensus of opinion in the Commission now is that while the locomotives which he repaired may be used the flat cars are so small that it will be greater economy to buy new ones.

The Spooner Act was passed in the spring of 1902. The President was not able to make an effective purchase from the Panama Canal Co. until May 4, 1904. I shall not stop to rehearse what is entirely familiar to you, the failure of negotiations with Colombia, the change of sovereignty over the Isthmus to the new Republic of Panama, and the recognition of that Republic by this Government, and the treaty by which we acquired the right to build the canal and assumed governmental control over a canal zone of 10 miles. These proceedings consumed a full period of two years.

In April, 1904, and after confirmation of the treaty, and in anticipation of the transfer by the French company of the canal property, the President appointed the Commission of seven, provided for in the act, as his agency for building the canal, and made Admiral Walker its chairman. A majority of the Commission, as required by the act, consisted of engineers, or army and naval officers who had had experience as such. The President became convinced that in order to secure detailed knowledge of exactly what was being done in the expenditure of this immense amount of money to build the canal, he should direct a member of his Cabinet to act for him in the supervision of his work, and he selected the Secretary of War. Of course this work was to be merely supervisory. It was not expected that the Secretary of War would meddle or interfere with the sound discretion and generally free hand which must be vested in those specially appointed to build the canal if successful results are to be accomplished by them.

The Commission effected a local organization in Washington in June, 1904, and, after inquiry covering several months, selected Mr. John F. Wallace as its chief engineer resident on the Isthmus. Maj. Gen. George W. Davis, U. S. Army, a member of the Commission, also went to the Isthmus to assume the duties of governor of the Canal Zone.

Before Mr. Wallace's appointment the Commission had employed surveyors and engineers and had sent them in parties to the Isthmus to make borings, surveys, and secure the data necessary to fix the exact type of the canal. When Mr. Wallace took charge he did much work in trying to find out what the French company had left on the Isthmus worth using, in repairing locomotives and flat cars found there, and in laying sufficient side tracks from Culebra Cut to make excavation and dump the material in a proper place. This was only experimental, and was for the purpose of finding the real cost of excavation per cubic yard. He also began the work of constructing houses for workmen. He designed and carried on the work of furnishing a water supply to the city of Panama, and he did considerable work on a sewer system. He did some work on docks at Cristobal and La Boca, and he laid some heavy rails on the railroad.

He complained much of the slowness with which his requisitions for material, supplies and equipment were furnished him. Complaints were continually coming to this country from employees and workmen representing that no sufficient houses were provided for them and no food either supplied them or to be purchased at reasonable prices. The yellow fever, in spite of the efforts of the sanitation bureau, began to show in the increasing number of its cases greater danger to the Americans employed by the Commission. Salaries were said to be much too low because of the high cost of any kind of living and the risk to health and life.

All these elements working together created something like a panic on the Isthmus among the employees of the Commission. They witnessed the arrival of the first supplies and equipment in such great quantity as to produce congestion and confusion, and, like an army without confidence in its leaders, they felt that chaos was at hand. I do not seek to place the blame for this on any one person, but rather on the method or system. I think there was error in not making more preparation for employees.

It thus became apparent during the six months succeeding the appointment of the first Commission that the body of seven men as organized was not an effective force for doing the work required in the construction of the canal. The members of the Commission themselves agreed that as constituted and organized good results could not be expected from it. In May, 1905, the President asked the resignation of the then existing Commission, and appointed a new Commission under certain regulations as to their procedure, by which he hoped to secure in practice greater centralization of power in the hands of a chairman and an executive committee less than the whole Commission, with its acts subject to confirmation by the Commission. He selected as chairman Mr. T. P. Shonts, who had had large experience in railroad matters, and who had shown by his energy and high character that he was well fitted to take upon his shoulders this most responsible task. As another member, capable of acting on the executive committee of the Commission, he appointed Mr. Wallace, the chief engineer, and as a third member he selected Charles E. Magoon, for many years the law officer of the Bureau of Insular Affairs, and a man who in the task of making new governments for our new possessions had been Secretary Root's chief law adviser, and a pioneer in devising ways and means for the purpose. To Shonts, Wallace and Magoon, as members of the Commission, were added four distinguished engineers, General Hains, U. S. Army engineer, who had devoted a great deal of time on a former commission to the investigation and report as to the construction of the canal; Colonel Ernst, also of the army engineers, who had been on a previous canal commission; Admiral Endicott, the leading civil engineer of the United States Navy and Chief of the Bureau of Yards and Docks; and Mr. Benjamin Harrod, a member of the former Commission and a member of the Mississippi River Commission.

Under the regulations prescribed by the President the Commission organized and appointed an executive committee, consisting of Shonts, Wallace and Magoon, and adopted regulations dividing the executive work between Mr. Shonts, who, as chairman, took charge of the Washington office, the making of contracts, and the purchase of material, and general executive control of the whole business of the Commission; Mr. Wallace, who was chief engineer, and had now become a member of the Commission and executive committeeman, who took immediate charge of the engineering and construction work upon the Isthmus; and Governor Magoon, who succeeded General Davis as governor of the Zone, and who assumed control of the whole sanitation of the Isthmus, with Colonel Gorgas as the immediate chief sanitary officer. This arrangement was put in force at once, and Governor Magoon and Mr. Wallace went to the Isthmus, while Mr. Shonts remained to reorganize the office of the Commission in Washington.

As already said, one of the difficulties encountered by Mr. Wallace upon the Isthmus had been the delays attendant upon his requisitions for all sorts of supplies which it was the proper office of the home organization to furnish him. They showed the necessity for a reorganization of the Washington office. Mr. Shonts drafted into service to assist him in the reorganization of this office Colonel Edwards, the Chief of the Bureau of Insular Affairs, whose experience in organizing his most efficient Bureau was regarded as of especial value at this time. David W. Ross, a gentleman of wide and varied experience as purchasing agent for great railway systems, was employed at a salary of $10,000 a year, and E. S. Benson, a gentleman having similar railroad experience as an auditor of many different railway systems, was employed at the same salary as auditor. It was not thought wise to economize in the matter of salaries to be paid in the selection of men upon whose skill, honesty and experience so much of the success of the canal work depends. Mr. Shonts himself received $30,000 a year, Mr. Wallace $25,000, and Governor Magoon $15,000.

I come now to the separation of Mr. Wallace from the service as chief engineer and commissioner. Mr. Wallace is a gentleman for whose engineering skill and whose high character as a man I had always much respect, and, except in one regard, my opinion has not changed. Mr. Wallace was certainly dissatisfied, as all of us were, with the workings of the first Commission, and had reason to be. He complained seriously of the delays incident to his work, due to the cumbersome machinery and the slowness with which decisions and action could be had by the old Commission. When the reorganization was determined upon Mr. Wallace was consulted by cablegram and advised of the new plan. This he fully and gratefully approved. He was directed to come to Washington for the purpose of fixing details. He did come and expressed himself as highly pleased with the result, and went back to the Isthmus full of the most superlative expressions that everything that he had hoped for in the reorganization was accomplished.

He had not, however, been back in Panama more than six days when I received a cablegram advising me that he must come to New York to discuss questions relating to his continuance as chief engineer of the project. I was greatly taken aback, for I heard indirectly from reliable sources that he had received an offer of a much higher salary and that he was determined to accept the offer and give up this job. Mr. Wallace came north and at an appointed interview stated to me that he had received an offer of $65,000 and had accepted it, that he was anxious to assist me and the members of the Commission, as far as possible, with his advice, and would be glad to continue as a member of the Commission, but that he could not and would not go back to the Isthmus at all. I gave Mr. Wallace a full opportunity to state all the reasons that actuated him in withdrawing, but this is the only one he mentioned. I told Mr. Wallace that his appointment had been solely as chief engineer resident on the Isthmus, that on account of the critical condition of affairs existing on the Isthmus, his presence there was of the highest importance, and that for him to cut off his relation to the Commission for a mere money offer and to decline without further notice to stay on the Isthmus and conduct the affairs of the Commission there showed him to be so subject to pecuniary motives that I did not think his continuing his relation with the Commission would be of any service to us.

Mr. Wallace feels that I have done him great injustice. He says that money was not the only consideration which led him to sever his relations; that there was too much red tape in the Government's methods of business and that the health of his family and other controlling reasons led him to his conclusion, but that at our interview he was so embarrassed by my evident feeling on the subject that he did not do himself justice in stating fully the cause of his withdrawal. He says that he was not under any contract obligation to stay, and that he might sever his relation at any time.

If Mr. Wallace was influenced either by considerations of the health of his family, or by a feeling that governmental methods were so in conflict with successful business methods that he felt that the job was too difficult for him, or by any other good cause, and the charge that mere pecuniary motives influenced him did him injustice, I deeply regret it; but I submit that my inference was justified by his failure to mention any reason for his action except a higher salary.

Mr. Wallace's course in declining without any notice to return to the Isthmus as chief engineer of the canal for any time, however short, was most embarrassing to the Government, for while he had organized on paper only some six or eight divisions of work upon the Isthmus, at the head of each of which there was to be an engineer of great experience, to be paid from $10,000 to $15,000 a year, he had in fact selected for these positions but one man. At the time Mr. Wallace laid down his office, conditions on the Isthmus were most chaotic, and it seemed to the President and to me that proper loyalty to the enterprise required that Mr. Wallace should remain on the Isthmus for a reasonable period, say at least six months, in which to enable us to fill his place and to complete the mere skeleton organization which he was leaving and which would necessarily fall apart on his withdrawal. He gave us no option as to whether he would return to the Isthmus or not. That, he said, was settled.

The publication of the interview with Mr. Wallace was made after consultation with the President, and was made not for the purpose of punishing Mr. Wallace, but because the public were entitled to know the facts and because it was hoped it would discourage others engaged in responsible positions in the construction of the canal from withdrawing at critical stages of the work without sufficient notice.

This is all there is of the Wallace incident, except that I have been very glad to assure the advisory board, or the board of consulting engineers, that I believed Mr. Wallace to be an able, experienced engineer and an honest man who had large opportunities for acquiring information which would be valuable to them. I advised them to call him. Mr. Wallace has fully and freely responded to the call and has answered all questions, and has declined any compensation whatever.

By great good luck, after Mr. Wallace's separation from the service, we found that we had then in the employ of the Government a man whose peculiar fitness to do the executive work of chief engineer on the Isthmus was fully shown, as investigation was made into his experience and reputation and his achievements as

a constructing engineer. I refer to Mr. John F. Stevens. We had employed him in the Insular Bureau to go to the Philippines and supervise the construction of 1,000 miles of railway, the bids for the building of which were to be opened on the 15th of December next.

With a good deal of hesitation Mr. Stevens, who was on the eve of his trip to the Philippines, accepted the new position proffered him, and went to the Isthmus in July of this year. The executive committee of the Commission now consisted only of Mr. Shonts and Governor Magoon, and the chief executive work in Washington and elsewhere falls upon Mr. Shonts as chairman, who is in general control, especially of the work of construction on the Isthmus, through Mr. Stevens. Governor Magoon still has charge of sanitation and of the Government of the Zone. The whole Commission meets regularly every quarter and acts upon that which has been done by its agents.

I come now to discuss the actual progress which has been made. By the 1st of December we shall have spent $60,000,000 in the course of acquiring a trans-isthmian canal. The two questions which the American people have a right to ask are, first, Have we proceeded without unnecessary delay? Second, Have we received our money's worth?

First, the Spooner Act was passed in the spring of 1902. The delay incident to Colombia's conduct certainly could not be avoided. No one can deny that we closed as quick as we could reasonably with Panama in December, 1903, and that there was no unnecessary deliberation in closing out the transfer of the French Panama Canal Company's property to the United States in May, 1904. The Walker Commission was appointed before the transfer. It lost no time in selecting a chief engineer. Mr. Wallace took hold in June, 1904. Considering all the obstacles, I think great progress has been made since then. That which was done in a year under Mr. Wallace and the old Commission seems less than what has been done under Mr. Shonts and Mr. Stevens and the new Commission in three months, but, in the nature of things, in the early days of a great organization like the human machinery for building this canal, progress toward smooth coordination and satisfactory results is slow.

Many thoughtless persons cry out "Why does not the dirt begin to fly? The way to build the canal is to dig." Such remarks only show the ignorance of the authors and their complete failure to understand the real character of what has to be done.

The canal is to be built by manual labor and machinery. The number of laborers required will perhaps be 25,000. Panama is a sparsely settled country, with few laborers available. The great majority of those employed must be imported. For every laborer brought in at least one person more will come who will be dependent on him. We must therefore count on an alien population of 50,000 to be distributed along the line of the canal for 47 miles. To get the best work out of the laborers, they and their families must be housed; they must have healthful food; they must have pure, good water to drink, and the filth and noisome drainage caused by such a collection of human beings must be taken care of so as not to promote disease. Finally, Panama has a history of awful losses of life among workmen engaged in the construction of the railroad and the canal from yellow fever and malaria, and these two diseases must be stamped out. All these things ought to be done before the "dirt begins to fly."

When Mr. Wallace left, the pay roll contained the names of 8,000 persons. Since Mr. Stevens has taken hold, in three months, this has been increased from 8,000 to 13,000. Under Mr. Wallace it was thought wise by the old Commission, and by Mr. Wallace himself, to make experiments in the cost of excavating earth in the Culebra Cut. He did this with some new excavating machinery, but principally with the old transportation machinery, and he reached some results, the value of which is in dispute. He feels confident that he has shown by his calculations that the cost per cubic yard of excavation in the Culebra Cut may be reduced below half of that fixed by the Commission, and this is used as an argument in favor of changing the type of the canal from a lock canal to a sea-level canal. Upward of half a million dollars were spent by Mr. Wallace and the former Commission in these excavations. Mr. Shonts and Mr. Stevens have not deemed it wise to continue them because they think the conditions under which the experiments were carried on are not like those which will prevail in the actual excavation, for the reason that the disposition of the spoil must be made at a very much longer distance and with a very much greater expense. I do not stop to pass on this difference of judgment between engineers, except to say that the excavation has been made and has reduced the work to be done to that extent. The objection made to the excavation at this time was that it may have prevented the devotion of more time and energy to the preparation of houses and of food supplies for the laborers. I do not know whether this is true or not.

The first thing that the first Commission did, and to them is the credit due, was to make arrangements for the construction of a water supply for Panama. Engineer Wallace and his assistants devised the plans, took a reservoir which had been partly constructed by the French, some 11 miles from Panama, built the dam 20 ft. higher and ran the water pipes to Panama, and then laid the mains into Panama, so that on the 4th of July, 1905, the water cocks in the city of Panama were opened, and the people were permitted to drink pure water. This reservoir furnishes water also to the towns between it and Panama on the Pacific side; but another reservoir for Culebra, another one for Empire, another one for Bas Obispo, and others for Colon are being constructed, together with water-pipe systems in all of them. Sewers are now being constructed in Panama, and about 50% of them have been completed. In order to make Panama really healthful the Commission has decided it to be necessary to pave the streets, which for centuries have been dirty—muddy in rainy weather, dusty in dry weather, and full of disease in all weathers. The whole Isthmus strip from Panama to Colon when our Commission went there first was grown up with underbrush, with weeds, and with all that jungle that a tropical soil and weather unrestrained rejoice in. Now, from point to point, as the population increases, as the work is elaborated, the jungle is being cut down, the hills are being shaved, and under the tremendous work of the sanitary department pools are being drained, swamps relieved of water, and in every way the stagnant water surfaces and the propagating ground for the deadly mosquito are being reduced. When one thinks of a strip 47 miles long and half a mile wide in the center of the Tropics, with marshy swamps and water accumulating everywhere, the task of reducing the stagnant water surface so as to prevent the generation of mosquitoes seems impossible. But it must be and can be done.

The mosquito is the worst enemy in the propagation of disease in the West Indies and American tropics that man has. One variety in the Isthmus carries the germ of the deadly yellow fever, and another variety carries the germ of malaria, while a third infects its victims with the loathsome disease of elephantiasis. Petroleum prevents the generation of mosquitoes. A yellow-fever mosquito lives only about ninety days. The custom of the yellow-fever mosquito is not to depart far from the place of its birth. It is not ordinarily born in the open. Its fellow who carries the malaria germ is born in the stagnant pools that are found in the meadows and on the hills and in the valleys, but the yellow-fever mosquito is ordinarily to be found in the forgotten corners of the cellars and dark rooms of tropical houses, in neglected utensils, in cisterns, puddles of water within the back yards, or in the closets of the residents. While with petroleum and with drainage a large part of the surface which generates the malaria mosquito may be reduced, the yellow-fever mosquito must be attacked in houses by fumigation, either with sulphur or pyrethrum. At one time it was thought sufficient in the town of Panama when a victim of yellow fever was taken from a house to fumigate that house and the two houses next, because the habit of the mosquito indicated that it did not depart far from the place of its birth. It seems that the mosquito that acquires and communicates the yellow-fever virus is a female, and this only during her period of gestation. She dies at the end of ninety days, and it is not known that her descendants continue to carry the poison. These limitations are what prevent the spread of the disease.

When Judge Magoon arrived upon the Isthmus he found Doctor Gorgas battling manfully against the yellow fever, but the cases seemed to be increasing. Judge Magoon conceived the idea that the fumigation which had been confined to two or three houses might well be extended to all the houses in Panama, and at considerable expense, and after procuring a large amount of material, every house in Panama was fumigated once every two weeks. To secure increased vigilance and popular assistance he employed all the respectable Panamanian physicians of Panama as inspectors of the districts of that city, at annual salaries of $1,200 a year. He also offered $50 reward for the discovery of any case of yellow fever not reported. By methods of this kind the native apathy, usually so great an obstacle to successful sanitation in Spanish countries, was neutralized.

The plan of fumigation is as follows: Strips of paper are placed across the windows, which ordinarily have no glass or any netting in them, and then either by the fumes of the sulphur or pyrethrum every nook and cranny of the house is visited. These gases are fatal or paralyzing to the mosquito. After sufficient time has passed the house is opened and then a corps of health employees are set to work cleaning the house and sweeping out the dead mosquitoes, which are found in great numbers upon the floors. The mosquitoes are burned to avoid further mischief. By these methods, for which Doctor Gorgas and Governor Magoon are both to be credited with great praise, yellow fever has been reduced to a point where during the last month only three cases were reported, not one of these among canal employees, and all originating many miles from the canal line. The efforts to subdue the fever instead of being relaxed are being continued. Square meshes of woven-wire netting with interstices so small as to prevent the entrance of mosquitoes are spread about the piazzas of the house of every American or foreigner who comes to live under the auspices of the Canal Commission in the Isthmus. The windows inside are also screened, and then mosquito bars on the beds are used as a third precaution.

Little by little, and facing discouragement after discouragement, the 2,000 employees of the sanitary department are winning in this fight against disease, upon which the whole success of the canal work depends. As Mr. Stevens said to me, when I crossed the Isthmus with him this month, "I take off my hat to the work which the sanitation department has done in this Canal Zone." Good food is now furnished by a commissary at reasonable rates. The carrying of refrigerated fruits and foods and meats on refrigerator cars from Colon across the Isthmus has just been begun. There is an ice plant at La Boca, another one at Colon, and others along the way are to be constructed, so that ice—that most healthful form of liquid in the Tropics—will be at hand for all.

A hotel has been erected at Corozal, where the American employees of the Commission may live and run to their business in Panama in a few minutes by railway. A hotel of 128 rooms is being constructed at Ancon, which is the Pacific terminus of the terminating township of the governmental Isthmian strip. The French had an excellent hospital at Ancon. They had also rather a large hospital at Colon. It was necessary, however, in view of the decay and lack of repair in which these hospitals were found, to refit them entirely. And now we have a hospital at Ancon, one at Panama, a convalescent hospital at Taboga, an island some 10 miles off the coast in Panama Bay, where very healthful water, healthful bathing, and fine fruits can be had, so that in all the hospital accommodation has been increased from about 350 to upward of 1,000 beds.

American trained nurses may be had at any point on the Isthmus, and any employee or laborer and any member of his family will be taken care of at these hospitals. The evidences of successful war against malaria are not so easy to produce as those of the defeat of yellow fever. An examination for experimental purposes, and repeated at various times under the direction of Colonel Gorgas, shows that at least 70% of people picked up at random in the Isthmus have the malarial microbe. I am glad to say that since our occupation the malaria has not generally taken on the malignant form of the days of the railroad and French canal construction, but is rather mild.

The great difficulty in preventing the transmission of malaria is that, with 60 or 70% of the persons infected with malaria, it is impossible to prevent malaria mosquitoes from happening upon the source of malaria supply in the blood of 60% of the inhabitants of the Isthmus. The cases of yellow fever, on the other hand, are comparatively so few that isolating them is a real measure of protection to all. Nevertheless, by the reduction in the total number of mosquitoes, which, though an enormous task, is still capable of accomplishment, the spread of malaria may be largely checked.

When the property of the French Canal Company was transferred, the Panama railroad was, from the standpoint of modern railroads, most inadequately equipped. It had a single track from Colon to Panama, with some sidings, very insufficient yards at the termini, and light rails, quite insufficient for the heavy traffic which was carried over it. The laying of the track with heavier rails had been projected by the company before the transfer, but only a few miles had been laid. The Commission, acquiring control of the railroad company, directed the purchase of rails so as to lay completely the whole line with the heavier rails, and now all but nine miles of the road is so equipped. The roadbed is as fine as any roadbed in the United States, ballasted in gravel and rock, and seems to be completely free from any possibility of washouts, but with this exception every other feature of the road as to structure and equipment is subject to criticism.

It is quite evident, and the Commission has so decided, that in order to transport the commercial freight which the railroad is under charter obligation to carry, and at the same time to transport to the spoil banks the excavated rock and dirt, it will be necessary to double-track the road nearly all the way from Colon to Panama. The exceptions are through narrow cuts or at the top of the grade over which the spoil from the excavation will not need to be carried. The recent work of construction under Wallace and Stevens has been the work of putting this road into proper condition, of making preparation to double-track, and of laying at various and suitable intervals long tracks leading from the Culebra Cut at various elevations to the points of the Panama Railroad to which the spoil may be hauled downhill from the point of excavation and thence carried to Miraflores on one side or to Colon on the other, to be dumped into swamps or else to be dumped into barges and carried out to sea and there disposed of. The amount of this track laying will reach 250 or 300 miles when completed, and it is one of the chief consumers of labor in the construction department at present. The work of excavation is con-

...atively easy, for with compressed air drills and blast-... and the 20 modern steam shovels which are now on ... ground, and the 60 more which are ordered, digging ...ght go on rapidly. With a sea-level canal at least ...,000,000 cu. yds. of material will have to be blasted, ...g cut, and carried from a few feet to 15 miles.

The great problem, however, is the problem of trans-...sting that which is dug to the point where it is to be ...ally deposited with such speed and such return of ... vehicles of transportation as to enable the shovels ... be in constant use. It is a problem of transportation ...ally and not of excavation. These figures suggest the ...ount of preparation in the way of increasing the ca-...ity of the railroad, of track laying, and of other me-...anical devices for disposing of the spoil which must ... made before the "dirt begins to fly."

In addition to this work, machine shops of the French ... to be repaired and in some cases rebuilt. Wharves ... being put up now in order to furnish additional ...ths for steamers at Cristobal on the one side and at ...a Boca on the other. There are to-day engaged on ... railroad proper about 4,000 employees; that is, there ... 2,500 paid for six days' labor, but they are not per-...haps the same 2,500. In addition to this there are 13,000 ...laborers on the pay-roll of the Commission, and that ...means about 10,000 effective laborers per day. As the ...work of construction of houses goes on, as the capacity ...for housing and feeding and properly attending to la-...borers proceeds, we may look for an increase in the ...pay-roll.

It should be borne in mind that all of the large equipment like locomotives, cars, steam shovels, dirt spreaders, and cranes have to be knocked down and boxed in order to have them carried by vessel to the Isthmus and there unboxed and reassembled before available for use. Still, as Mr. Stevens himself told me, everything grows better from month to month. The exasperations and frictions of early organization are passing away as matters move with more smoothness.

Nearly all the labor upon the Isthmus is now negro labor from the West India Islands. It is very poor. The question remains to be decided whether we shall attempt to secure Chinese or Japanese labor. It has been held by the Attorney-General that the Federal eight-hour law applies to those employed by the Canal Commission. I was at first disposed to think its effect would be good, because we could have three shifts every twenty-four hours. I am assured, however, by Mr. Stevens and Governor Magoon that its enforcement only interferes with good work. Petitions are being filed by all foreigners and Americans asking that its operation in the Zone be amended. There is practically no limit to the negro labor we can obtain from the West Indian and Caribbean Islands, but its efficiency is so low that we may have to call in Asiatics. Another year will show more facts upon which a labor policy may be based. The fact that no white labor can be found to stand work in the tropical sun ought to remove the question from the forum of ordinary trade-union labor discussion and lead to a solution free from considerations which might properly have great weight in a more temperate climate and in conditions less resembling a national emergency.

I visited the Isthmus a year ago and again this year. I am unable to see a marked difference, even in outward appearances, and to say with much emphasis and certainty that real work has been done and is being done. The effect of better housing for the employees, the influence of the successful efforts of the sanitation department to stamp out yellow fever, the confidence of the American subordinate engineers, foremen, clerks, rodmen, and others that there is a competent and skillful head to the enterprise in Mr. Shonts, knowing what is being done in each department, and coordinating all departments, tends to give an atmosphere of conscious progress, individual interest, and patriotic pride in the great task of a great nation.

Ten millions were voted to begin the preliminary work on the canal. That $10,000,000 is about exhausted.

The pay-roll at present amounts to something like $600,000 a month, and there is not enough money on hand after the payment of the bills to meet the December pay-roll. There are bills unpaid for material and supplies which should be paid at once. The delay is quite oppressive and unjust to the creditors of the Government. It will be necessary, therefore, for Congress to make an emergency appropriation to carry on the work without calamitous interruption.

Nothing could be more disastrous than to have the pay-rolls go unpaid for even a few weeks. This was the trouble with the New French Panama Canal Company, and with the Old French Panama Canal Company. Certainly there is nothing in the credit of the United States justifying suspension of payments. I know there is a disposition in some quarters, and possibly among some members of Congres, to reinvestigate everything connected with the canal. But while this desire to know all about the canal and its construction is most commendable, it will hardly be allowed to delay the current appropriations for the daily work by 13,000 laborers that is now being so successfully carried on.

It may be asked why have the conditions been allowed to arise under which an emergency appropriation must be asked. The answer is that those responsible deemed it their chief duty to push the work, to buy needed plant and material as rapidly as possible, and to increase the pay-roll as far as provision could be made for the housing and comfort of the additional laborers and employees. It was supposed that an extra session of Congress would be called in October, when ample time would have been given for deliberation in making all the necessary appropriation.

Now, it will be necessary to make partial appropriations to pay current bills and meet the necessary pay-rolls until the type of the new canal has been fixed and definite estimates for each fiscal year's work can be submitted to Congress, as in the case of all other general appropriations of Congress. Assuming that the type of canal is properly fixed, the faster the work is done the better every one will like it. It is important only that the money shall not be wasted by haste and that the country shall receive the worth of its money. Subject to this limitation, the greater the amount we can spend in a year in building the canal, therefore, the better.

One of the great obstacles to success in building the canal is the opposition of powerful persons and interests to its construction. Some of this opposition comes from those who are sincerely convinced that the Panama route is not a practicable route, and that there are other and easier routes to be preferred. It is not to be expected that owners and managers of great transcontinental lines should become enthusiastic over an enterprise which, if carried to completion, must certainly affect the rates of freight between the Atlantic and Pacific coasts. The opposition of powerful interests to the building of the canal takes different forms. It is found in the misrepresentations of conditions on the Isthmus, in unfounded reports concerning friction between those having authority in the canal work, in intimations of irregularities and frauds and favoritism in contracts without any evidence whatever to justify suspicion, and generally in the constant suggestion of a presumption that the expenditure of millions in building the canal must involve what is called "graft."

Doubtless Congressional investigations will be held from time to time. Doubtless they ought to be held to reassure the public; but if they are to be permitted to delay the work on the canal and to paralyze the energy of those upon whom the burden of pushing the work must fall, then they will be productive of evil and will become exactly what many private interests would be glad to have them become, the grave of all the high hopes for a trans-Isthmian canal. The American people will not permit such a catastrophe.

THE COMPLETION OF FORTIFICATIONS of the sea coasts of the United States will require $16,000,000, in addition to $28,693,000 already expended, according to a report by Gen. Alex. Mackenzie, Chief of Engineers, U. S. A. Other work is projected.

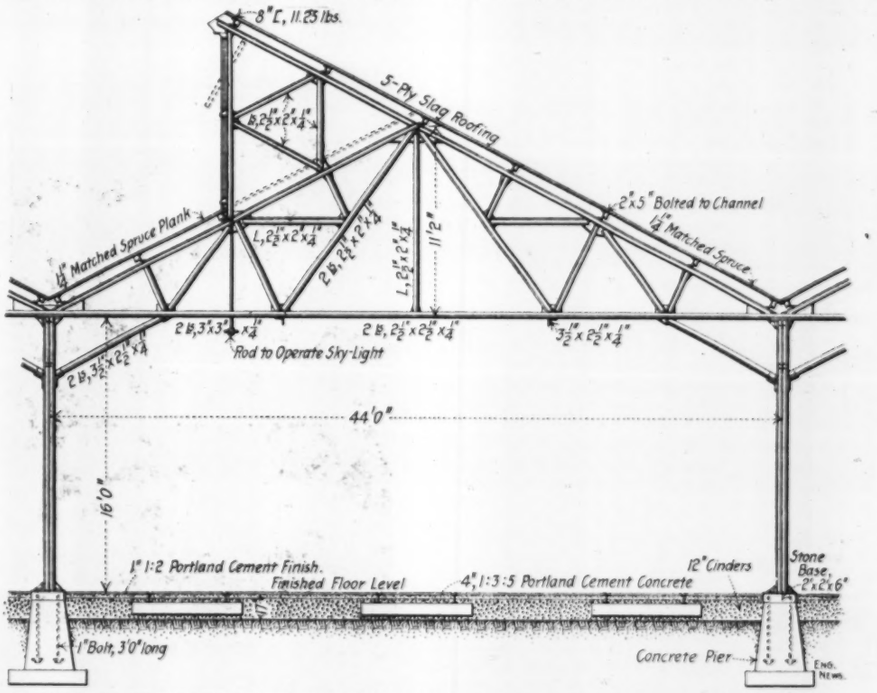
MODIFIED SAW TOOTH ROOF AS USED IN NEW PAINT SHOP OF THE PUBLIC SERVICE CORPORATION, NEWARK, N. J.

By M. S. Ketchum,* Assoc. M. Am. Soc. C. E.

Some time ago the writer proposed† a modified form of saw tooth roof and stated that it had many points of merit over the ordinary form of saw tooth roof. This modified saw tooth roof has recently been used in the paint shop of the Plank Road Shops of the Public Service Corporation of New Jersey, Newark, N. J., as shown in the accompanying drawing of one truss bay.

The building proper is 135 ft. wide by 354 ft. long. The main trusses have 44-ft. span and a rise of ¼ the span, and are spaced 16 ft. on centers. The building has an independent steel framing with brick curtain walls on the exterior. Pilasters 24 ins. × 20 ins. are placed 16 ft. apart under the ends of the trusses, the intermediate curtain walls being 12 ins. thick.

The roof is a five-ply slag roof laid on 2-in. tongued and grooved spruce sheathing, which is spiked to 2 × 5-in., spiking strips which are bolted to 8-in. channel purlins spaced 6 ft. on centers. The slag roofing is laid to comply with standard specifications, as described in "Steel Mill Buildings."† The roof water is carried down 5-in. cast-iron leaders attached to alternate interior columns.



KETCHUM'S MODIFIED SAW-TOOTH ROOF, AS USED IN NEW PAINT SHOP OF THE PUBLIC SERVICE CORPORATION, NEWARK, N. J.

The sash in the vertical leg are in two rows, the upper row being hinged at their centers, thus providing ample ventilation. Condensation gutters are placed below the vertical leg (on the inside) to take the drip. The skylight area is about 20% of the roof area, the window area is about 45% of the outside walls; thus about 28% of the entire outside surface of the building is of glass. All glazing is of ⅛-in. ribbed wire glass, with the ribs placed vertical. The skylight frames and moldings are made of No. 24 galvanized iron, while the entire roof is flashed with 16-oz. copper sheets, 4 ft. wide, and counter-flashed with sheet lead.

The principal advantages of the modified saw tooth roof are stated in the writer's "Steel Mill Buildings," as follows: "This modified saw tooth roof allows the use of ordinary valley gutters, and gives an opportunity to take care of the condensation on the inner surface of the glass by

*Dean of the School of Applied Science, University of Colorado, Boulder, Colo.

†In "The Design of Steel Mill Buildings and Calculation of Stresses in Framed Structures," Milo S Ketchum, C. E., Engineering News Publishing Co., New York, N. Y.

suspending a gutter at the bottom of the monitor leg. Snow will cause very little trouble with this roof on account of the increased depth of gutter. The modified saw tooth roof has a greater pitch, and permits the use of a more economical truss for long spans than the common form of saw tooth roof."

The writer is indebted to Mr. Charles A. Sterling, Vice-President of the Public Service Corporation, for drawings and information.

RECOMMENDATIONS AGAINST A 150,000,000-GALLON ELECTRICALLY DRIVEN PUMPING PLANT FOR BUFFALO, N. Y.

Vertical high-duty triple-expansion engines, rather than electrically driven centrifugal pumps, were recommended for the Buffalo water-works in a report made a few weeks ago by Col. Thos. W. Symons, U. S. A., Gen. Geo. S. Field and Rudolph Hering. These gentlemen constituted a water commission to report on improvements in the water-works of Buffalo. They advised a new intake, to be located in the Emeral Channel of Lake Erie, an intake tunnel, the rebuilding of the present pumping station, and the construction of a new one, supplementary water mains, a waste inspection service, and the gradual installation of water meters, to be owned by the city. They also endorsed the purchase of a 25,000,000-gallon electrically driven pump for the present station, and also of two 30,000,000-gallon steam pumps, bids for all of which have been received; but qualified their approval of the steam pumps with reservations as to securing satisfactory pumps under the bids.

The proposed large new pumping station would be located at Porter Ave., and would give the city, after the present station is overhauled and new installations in it made, duplicate stations of 15,000,000 gallons daily capacity.

The portion of the report discussing the relative advantages of electrically driven low-duty centrifugal pumps and steam-driven high-duty vertical plunger pumps is as follows:

We have given mu h attention to the method of equipping the new Porter Ave. station. We are aware of the fact that it has been proposed to equip this station with electrically driven turbine pumps, the electric power to be furnished by some of the Niagara Falls Power companies. But we find objection to this method of equipment and cannot approve of it. The turbine pumps are very low duty machines requiring from 50 to 100% more power for an equal amount of work accomplished than high-grade high-duty triple-expansion vertical plunger pumps. Turbine or centrifugal pumps working against the high pressure required are as yet experimental as regards wear and cost of maintenance and continued efficiency.

As to the power to operate these pumps, we believe that it is unsafe to depend on electric power transmitted from Niagara Falls. Accidents and trouble causing a shut down of the whole station may occur at any time to this power due to physical injuries to the transmission lines from natural causes, carelessness or malice, to electrical storms, to accidents at the power houses or to other causes. Thorough dependence for uninterrupted delivery cannot be placed on this electric power, and if it is installed it will be necessary and proper to equip the station with some auxiliary power development plant which can be quickly brought into use in case of interruption of the current. This auxiliary power might be obtained from gas, oil or steam engines. The attractive feature of electric power installation is its low first cost, but if to this is added the cost of providing a plant for auxiliary power and the extra cost of operation, this advantage then disappears.

Furthermore, we are of the opinion that the city should own and control the entire water supply system of the city, its power development plant as well as the pumps, tunnel and intake. Grave and serious complications might arise in connection with the operation of a water supply plant, the power for which is obtained from foreign power development companies uncontrolled by the city and which has to be transmitted from the Falls with the certainty of interruptions.

The combination of purchased electric power from abroad with a low duty centrifugal pump for the water-works of the city we do not believe is a good and economical combination for the city to adopt, and electric power is not suitable to operate the kind of pumps that we believe it best to install.

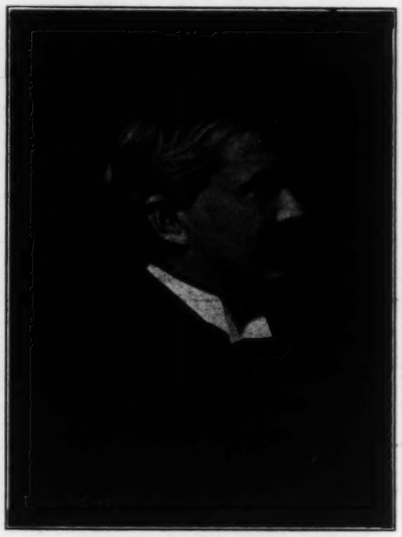
We are convinced that the most reliable and economical power, all things considered, for the new station, is steam power, furnished by the best type of modern boilers equipped with mechanical stokers and smoke consuming devices, and that this power should be used in operating vertical, high-duty triple-expansion plunger pumps.

We are further convinced that a steam pumping station can be so built and operated that it will not be any more detrimental to park interests than would be an electric pumping station. In fact, such a station in an accessible location like that at Porter Ave. can be made most attractive and would doubtless be visited by large numbers of interested people.

ALBERT J. PITKIN.

Albert J. Pitkin, President of the American Locomotive Co., died at his home in New York City on November 16. He had been ill several months, but the seriousness of his condition was appreciated by only a few of his closest friends, and the news of his death was a surprise to all. His life was a constant active association with locomotive construction, and had strong influence in molding the development of the art.

Mr. Pitkin was born at North Hampton, O., in 1854. At the age of 17 he became apprentice in the stationary engine works of the Webster, Camp & Lane Machine Co., of Akron, O., and later spent a year in the locomotive repair shops of the Cleveland, Akron & Columbus R. R. By diligent evening study he prepared himself for designing; in 1875 he entered the drawing office of the Baldwin



Albert J. Pitkin.

Locomotive Works, Philadelphia, and remained there five years.

His subsequent life was given wholly to locomotive work. He became chief draftsman of the Rhode Island Locomotive Works, and after two years in this employ he was appointed Mechanical Engineer of the Schenectady Locomotive Works, at Schenectady, N. Y. Two years later he advanced to the position of Superintendent of this company. Upon the death of the President, Edward Ellis, Mr. Pitkin was made Vice-President and General Manager, and from that time developed the commerical as well as the manufacturing features. He had much to do with winning for the Schenectady Locomotive Works their high standing among the locomotive building establishments of the country. Upon the formation of the American Locomotive Company Mr. Pitkin became its First Vice-President, and upon the death of S. R. Callaway, on June 1, 1904, Mr. Pitkin succeeded him as President.

Mr. Pitkin's life being always directly connected with locomotive construction may be measured by his achievements in this field. An energetic enthusiasm for locomotive development was one of his prominent characteristics. He must be accorded large credit for the marked advance in the capacity of locomotives which began a dozen of years ago. He was exceedingly active in the introduction of fireboxes over locomotive frames, and in the increase of steaming capacity by using larger boilers. One of the last important developments which engaged his attention was the application of Walschaert valve gear, and the introduction [illegible] American practice of the Mallet type of [illegible] pound, which he considered a distinct step in advance in locomotive designing.

But his influence extended beyond locomotive construction. He was concerned in all matters relating to motive power management, and originated many improvements in methods. He was a most generous and considerate employer, and was sincerely interested in the welfare of the army of men. At the head of the greatest industrial organization of its kind, he had an influence which extended beyond the boundaries of the country.

NOTES FROM THE ENGINEERING SCHOOLS.

PURDUE UNIVERSITY—The experimental locomotive of Purdue University, "Schenectady No. 2," which has recently served in an important study designed to determine the value of very high steam pressures, is to be sent to the Schenectady Works of the American Locomotive Company early in November for the purpose of being fitted with a Cole superheater. It is expected that the engine will be returned with its new equipment early in January.

During the absence of Schenectady No. 2 from the testing plant, a New York Central Atlantic type engine is to be installed upon the plant for use under the direction of the Master Mechanics' Committee on Front-Ends. It is the purpose of this Committee to repeat upon an engine of large size the experiments made under the patronage of "the American Engineer" upon Schenectady No. 2, for the purpose of determining the constants in such equations as may be necessary to the logical design of all portions of the front-end mechanism. The Master Mechanics' Committee having the matter in charge consists of Mr. H. H. Vaughan, Supt. Motive Power, Canadian Pacific Railway, Chairman, Mr. F. H. Clark, Gen. Supt. Motive Power and Machinery, C. & N. W. Ry.; Mr. A. W. Gibbs, Gen. Supt. Motive Power, Penna. R. R., Mr. W. F. M. Goss, Purdue University, Mr. G. M. Basford, American Locomotive Co.

Mr. Henry F. Shaw, of Boston, well known in railway circles for his work on the problem of balancing the reciprocating parts of locomotives, has presented to Purdue University a model locomotive, on a scale of 1 inch to the foot, embodying his latest design.

NOTE ON A METHOD OF CONDENSING STEAM BY THE USE OF MODERATE QUANTITIES OF WATER.*

By Charles Haynes Haswell,† M. Inst. C. E.

An elongated cylindrical metallic vessel or condenser, set in an inclined position, is filled with light copper, bronze or lead tubes of small diameter, say ¾-in., disposed similarly to the tubes of an ordinary surface-condenser but placed as close together as practicable, the length of the tubes being proportional to their diameter and to the difference of temperature between the steam and the condensing-water. The steam is led or exhausted through the tubes, and the condensing-water, being projected in minute sprays against the faces of the upper ends of the tubes, gravitates into them, and passing through them condenses the surrounding steam; the water of condensation gravitates to the lower end of the vessel, whence it is exhausted by a pump, and forced back into the boiler or otherwise applied as may be required.

In this manner a small volume of condensing-water in minute globules, within the small metal tubes, on account of the proportionately large surface presented to the steam, readily and effectually absorbs the heat of the steam surrounding it, and a smaller volume of water is required for the condensation of a given volume of steam than is necessary with the ordinary methods of condensation in jet or surface-condensers.

The head necessary for the injection of the condensing-water may be obtained either gravitationally or by means of a pump. In land-service, a sufficient head can be obtained in most towns and cities from the reservoirs of potable water.

*From the "Proceedings" of the Institution of Civil Engineers.

†324 West 78th St., New York City.

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According to the press correspondents at Washington, the Board of Advisory Engineers on the Panama Canal, has disagreed on the main question as to the type of canal to be built, and majority and minority reports will be presented. The majority report, favoring the sea-level plan, is said to be signed by the five foreign members of the Board and also by Gen. Davis and Messrs. Parsons and Burr, who by action on the previous commission were more or less committed to the sea-level plan. The other five American engineers on the Board, Gen. Henry L. Abbot and Messrs. Alfred Noble, F. P. Stearns, Joseph Ripley and Isham Randolph, are said to have held out in favor of a lock canal.

We print this report at the present time for whatever it may be worth. No official statement as to the results of the Board's work is likely to be made before the presentation of its report to the President, through the Canal Commission. It may be said, however, that the dispatch is confirmatory of previous newspaper statements as to a difference of opinion in the Board as to the best type of canal.

There can be little doubt that a unanimous report from the Board in favor of either type would have been accepted by the public and by the Executive and Congress as permanently settling the question; but a substantial division in the Board leaves it doubtful which type Congress may approve. There appear to be strong indications that the Canal Commission itself is in favor of the lock canal. The interests which oppose the building of any canal, however, are likely to throw their influence in favor of the sea-level plan, in the hope that its great cost and long time required for completion may defeat the entire project.

We reprint on another page from the "Proceedings" of the Institution of Civil Engineers of Great Britain, a paper by the venerable Chas. H. Haswell, who is now in his 97th year. We risk little in saying that Mr. Haswell is not only the oldest engineer in the world, but that never before has a contribution to engineering literature been made by a writer at such an advanced age. Withal, his paper is the shortest that has ever found a place in the published proceedings of the Institution.

The large amount of contract work in progress or about to be awarded in the Philippines, as well as a broader interest in the questions involved, render timely the two papers on labor and sanitary conditions in those islands which we publish elsewhere in this issue. The longer of the two articles, we venture to say, is the most exhaustive review of labor conditions affecting engineering and contract work in far-away colonies or dependencies ever written by an engineer for the benefit of engineers, contractors and students of economics and political government. The article may be considered as authoritative as it is exhaustive, since it was written by Mr. J. W. Beardsley, M. Am. Soc. C. E., Consulting Engineer to the Philippine Commission. A striking feature of Mr. Beardsley's article, as also the article on municipal improvements at Manila, by Major J. F. Case, M. Am. Soc. C. E., Chief Engineer of Sewers and Water-works Construction, Manila, in our issue of Oct. 19, 1905, is the hopeful and humane view there presented of native or Filipino laborers. Mr. Beardsley's article, it should be noted, is broader than its title indicates, since it gives meteorological and other data valuable to engineers and contractors in the Philippines. Sanitary conditions affecting contract work in the Philippines are also treated by an author who writes from personal knowledge: Major E. C. Carter, Surgeon U. S. A., late Commissioner of Public Health at Manila. The sanitary precautions suggested by Major Carter are simple, but none the less necessary. Major Case's paper, in our issue of Oct. 19, also bears upon sanitary conditions. The three papers should be studied by everyone engaged in contract or engineering work in the Philippines, or interested in the industrial and political future of those islands.

The matter of raising the legally required percentage of air-braked cars in a train, on which a hearing was held by the Interstate Commerce Commission as reported in our issue of Nov. 9, has now been decided by the Commission. An order has been issued raising the required proportion of air-braked cars in a train to 75%, to take effect Aug. 1, 1906. The present legal requirement is 50%.

Judging by the showing made at the recent hearing, the railways will experience no serious difficulty in meeting this requirement on interstate traffic. Out of about 1,900,000 freight cars in the United States on Oct. 1, 1905, according to the Interstate Commerce Commission figures, only about 225,000 are still without air brakes. To a large extent these are old cars of small capacity which have not been deemed worth the application of brakes. If these cars are to continue in service at all they ought to be relegated to local branch lines where they will not handle interstate traffic. To run such cars in general interchange is a standing invitation to accident every time one of these old and weak cars is made up in a long train. If the Commission's order tends to shut out these old cars from general interchange, it will be for the benefit of the railway companies.

Of course a considerable proportion of such cars can still continue to run with little risk of enough cars getting into a train to exceed the legal limit of 25%; but there can be no doubt that the legal limit will soon be raised to 100%. In other words, every railway car will soon have to be equipped with air brakes as it is now equipped with automatic couplers. The original law and the present order aims to give the railway companies a reasonable time for equipping their rolling stock; but dilatory action will certainly result in penalty.

Considering the enormous amount of explosives used at the present day, there is singularly little information available in engineering literature respecting their safe handling. People in general do not appreciate to how great an extent lives and property everywhere are placed in jeopardy by the proximity to quantities of high explosives in process of transportation from the factory to the place of final use. As the table in our issue of Nov. 9 showed, the production of explosives in the United States in 1900 amounted to nearly 216,000,000 lbs., and with the same rate of increase as that in the previous decade it is probable that the production is now in excess of 250,000,000 lbs. per annum.

In the last two or three years several serious accidents have called public attention to the need of greater precautions in the handling of explosives. Particularly notable were the explosion of a dynamite magazine at 42d St., New York City, during the construction of the Rapid Transit Subway, the wreck of an electric car in the suburbs of Boston a year or more ago by striking a package of dynamite which had dropped from a wagon, and the disastrous accident near Harrisburg, Pa., in May last, which called the general attention of railway managers to the need of greater precautions in the transport of explosives by rail.

The official rules just approved by the American Railway Association, which are printed in this issue, are worth the careful attention of engineers and contractors who have to use high explosives, particularly in the cases where engineering work is carried on in cities or other populous districts. Every engineer or contractor using high explosives in large quantity ought to see to it that printed rules for the safe handling and use of such explosives are furnished to every workman in any way responsible for the handling of explosives, and that these rules are read and properly understood.

The chief objections against equipping a large water-works pumping station with electrically driven turbine pumps are stated in an abstract from a report by Colonel T. W. Symons, U. S. A., General Geo. S. Field and Mr. Rudolph Hering, printed elsewhere in this issue. The abstract is so brief that it is unnecessary to summarize the objections here, but we do wish to call attention to the opinions advanced. All things considered, the conservative attitude of the commission appears to be warranted, particularly in view of the great size of the installation (150,000,000 gallons a day), and the fact that the city would not control the power for operating machinery so vital to its existence as a plant affording protection against both fire and disease. Moreover, Buffalo is about to install a 25,000,000-gallon electrically driven pumping unit, which will afford an opportunity to test electrical pumping on a large scale. The enormous use and waste of water now prevailing and rapidly increasing at Buffalo will afford chances enough to install electrically driven pumps in the future if warranted by the experience obtained with the proposed 25,000,000 pump and with electric power for pumping elsewhere. We do not doubt, however, that the advocates of both turbine pumps and electrical power will be able to put forth some strong arguments in favor of installing their apparatus on any scale at once. To mention only one line of argument, as applied to Buffalo, they might say that since the proposed plan for improvements to the water supply includes two immense pumping stations, each in excess of the present average daily consumption, the city would be in little danger if the contractor for electric current was temporarily unable to meet the demand. They might add that if the electric power plant of one company failed current could be obtained temporarily from another one. They might go still further, and speak of the advantages of electric power for one of the duplicate stations in case of a coal famine. Further arguments on this side of the question we will leave for our readers to advance.

CONCRETE BLOCK CONSTRUCTION AND THE ARCHITECTS.

The intrinsic merits of hollow concrete blocks will ultimately give them a prominent place among modern building materials. This assertion is made with a full realization of the limitations of the new material and of the conditions responsible for its present imperfect development. A material that at its best has the value of natural stone in its physical properties, that can be molded to any form to which stone can be cut, and that shape for shape and volume for volume is far less in cost than cut stone has just claim to a place in the work of architects.

The imperfect development of concrete blocks as a building material is a conceded fact. They are neither so widely used as they might be, nor, where used, do they give the results aesthetically and structurally that they are capable of being

made to give. The responsibility for this condition rests partly on the architect who has done little to develop the architectural possibilities of the new material and partly on the block maker who has applied false standards of beauty and utility to his product. These charges are severe, but they can be proven by the best of evidence.

Concrete block manufacture originated with the idea chiefly in mind of producing an artificial stone capable of competing with brickwork in the construction of building walls. Incidentally, it may be stated that the great bulk of block manufacturers have never gotten away from this original conception. To compete with brickwork the manufacturer was compelled to sacrifice everything to cheapness. There was no possibility of doing anything at the low price set as a goal but produce a concrete block of the plainest and most economical form. The sole aim must be to duplicate a chosen size and shape of block as many times and as frequently as possible. The molding machines put on the market by various inventors were devised with the object chiefly in view of producing a cheap block. Their range of adjustability was limited to the molding of half-blocks or quarter-blocks and to the production of such face patterns as could be managed by a simple change of face plates. On the other hand every possible mechanical device for increasing the output of blocks was utilized.

The result of this was that although working with a plastic material capable of almost limitless variations in form and texture the block maker succeeded only in producing one of the most rigidly regular and monotonously uniform building units ever put on the market. It is true that he produced a building material which was cheap, in fact marvelously cheap, but it was one which he could not get specified by architects for the better class of buildings. Concrete blocks found use only in the plainest of wall construction, and here they struggled with brickwork for a place. In many cases the block makers sacrificed quality as well as flexibility of form and size, and thousands of blocks were made that were so porous, ragged and weak that they were dangerous to use. This still further damned the concrete block in the eyes of the architect.

We have spoken as if the conditions set forth were a thing of the past. They are this only in case of the better class of block manufacturers. The original idea that the mission of concrete blocks is chiefly to replace brick as a structural material still prevails with the majority of block makers and of block machine builders. The idea that cheapness is an end in itself is hard to get away from. In visiting recently a number of concrete block buildings under construction the writer was warned in each case that he would not see concrete block work at its best. Why? Forsooth the architect had refused to adapt his design to the standard blocks produced by the machine in use. He had planned his windows so that odd size blocks had to be made to fit the masonry to the window arrangement; he had demanded blocks shallower or deeper than the standard for certain courses where he thought that appearance would be enhanced by the change; he had demanded various face dimensions in order to secure a chosen bond that he considered desirable to the looks of the building; he had done other irregular things too numerous to mention. Wherein was the sin in all this, it may be asked. The blockmaker's answer was that it decreased the output of his machine, it increased the cost of the blocks, it increased the cost of the walls, it made concrete block work far more expensive than brick work. The sin was that cheapness had been sacrificed.

In justice to the industry, it should be said that these ideas do not prevail with the most progressive and intelligent block manufacturers. They stand ready to execute the architect's plans, and they invite work on this basis. Every block manufacturer who desires to see his product go into building work of the better class must do the same. This means that his standard of attainment must be the production of a material that will compete with the best natural stone for most building purposes. There will always remain cellar walls and cow barns to be built, and the single block man will do as well at these as anyone, but the block manufacturer who intends to meet the quarryman in the architect's office and on an equal footing must stand ready to duplicate the quarryman's product size for size and shape for shape, and to do it for less money.

Duplication in the sense that it is urged here does not mean imitation. Only a few of those who have imbibed the broader doctrine of competition with natural stone have perceived this fact to the fullest degree. Imitation of natural stone has a small place, if any place at all, in the work of the concrete block maker. Honesty is as vital a principal in art as it is in trade. It is not honest to give to concrete a pretense of being what it is not. Moreover, concrete does not need the factitious aid of a simulated pitch face dressing in order that it may satisfy the eye in building construction. The pride of the worker in the material with which he works should alone prevent him for masking its identity.

The block maker may ask at this point if he is to abandon coloring, ornamentation and surface dressing for his product. The answer is, certainly not. Coloring may be used as freely as he chooses so long as it is used with taste, but it should not be used for the purpose of imitating a natural stone. In the same way the block maker may hammer-dress or chisel the face of his concrete, but he should do it not to make it resemble cut stone, but simply for the variation in surface texture in the same material that proper tooling may be made to furnish. In the matter of ornamentation the block maker is at equal liberty, but he had better do as the quarryman does and produce his ornamental work only to the order of the architect. We shall at another time have more to say of the possibilities of surface finish and ornamentation in concrete work. Here we wish merely to prescribe a single broad precept to be obeyed in their use. Let the block maker shun imitation, and work for appearance always within the limitations of his material.

Concrete has so many advantages as a building material that it is frequently forgotten that it has its limitations. Concrete is concrete always. A natural stone may be granite or marble or onyx. Concrete has beauty of its own which may be properly enhanced in a variety of ways, but it has not the peculiar beauty of marble or of granite, and the architect cannot be expected to choose it when he wishes the color and texture effects peculiar to granite or marble. Furthermore, he will not, if he be an artist, choose an imitation. In conversation recently a very prominent architect said: "These block makers come in here and say, 'why don't you use concrete blocks?' I can make a block that ten feet away you can't tell from red sandstone or marble or what not? Now I don't wish a concrete block that I can't tell from sandstone. I wish a concrete block that won't 'flower.' When I wish sandstone I can get sandstone." The rebuke in these statements is just; the business of the concrete block maker is to make concrete blocks and to make them without defects and not to make imitation sandstone.

The discussion so far has borne rather heavily on the shortcomings of the block maker, but the architect has been quite as negligent of his obligations if these may be assumed to exist at all in lending his aid in developing the possibilities of new structural materials. In a recent article written by an architect we find the following statement: "The architect will be ready to use their products (concrete blocks.—Ed.) the moment it conforms to his conception of what constitutes a pleasing as well as a durable building material." Possibly it would not be professional good form, but it occurs to one not an architect that the architect's interest and activity might well go a step further. He might tell the block maker what he would consider to be pleasing, or failing in this he could at least tell him wherein his present product was unpleasing. This would help somewhat toward reaching the lofty plane where their product would conform to the architect's conception of what constitutes a pleasing building material. It would help matters considerably more, however, if the architect would devote a little study to ascertaining if possible how by adopting suitable architectural styles and finishes and forms of blocks, concrete blocks could be made to work out pleasingly to the eye in building construction. There is no insuperable obstacle to doing this in fact it has been done for a few special structures. The Royal Bank of Canada building in Havanna, Cuba, illustrated in our issue of [illegible] 12, is one of these structures. We can point out others that are fully as enlightening as to the architectural possibilities of concrete block. They are equally enlightening to the block maker for they show him what he must do if he is to gain a place with architects for his product in competition with cut stone.

LETTERS TO THE EDITOR.

The Responsibility for Errors in Survey.

Sir: In connection with the discussion on the question of the responsibility of surveyors, the following quotation may be of interest. It is from an address on "The History of Surveying in Chicago," delivered at the annual meeting of the Illinois Society of Engineers and Surveyors, 1905, by the veteran Chicago surveyor, Mr. Samuel S. Greeley.

Chicago, Nov. 17, 1905.

A question always of vital interest to the surveyor is how far he may be held liable in damages for errors in judgment or faulty work, or for difference of opinion with other surveyors as to the location of boundaries. The only case wherein this question has been submitted to the courts for judicial decision, so far as I know, was in the year 1856. William Clogher, then City Surveyor of Chicago, was sued for the mislocation of a building to be erected at the southwest corner of State and 12th streets. The building, which had reached the second story, was adjudged to be encroaching some 2 ft. upon 12th street. It was taken down, and damages found against the surveyor in about $900. No appeal was taken, and the case was settled. Since that time in several cases damages have been paid by surveyors, without contest, for palpable and admitted errors.

Formulas for Crown Thickness of Masonry and Concrete Arches.

Sir: Referring to the Cannington viaduct, Axminster and Lyme Regis Ry., England, which is illustrated in your issue of Nov. 2, 1905, p. 452, I note that the depth of the key stone is 2.5 ft., the span being 50 ft. and the rise 16 ft. Applying my formula for depth of crown thickness in masonry arches, I find the resulting thickness is 2.3 ft., a close agreement.

The formula in question is as follows:

$$d = \tfrac{1}{8}\sqrt{(S - R)\,10 + 2\,H}$$

in which

S = Span, in feet.
R = Rise, in feet.
H = Depth of surcharge over arch, in feet.
d = Thickness of arch at crown, in feet.

In this connection it is interesting to note a formula for crown thickness of reinforced concrete arches, as published in a recent number of the "Engineering Record" by Mr. F. F. Weld, C. E. This formula is as follows:

$$c = \sqrt{S} + 0.1\,S + 0.005\,L + 0.0025\,D.$$

Where c = thickness of arch ring at the crown in inches
S = clear span in feet.
L = live load per square foot, uniformly distributed.
D = weight of fill over the crown per square foot.

This formula ignores a most important factor, and that is the rise, which, I think, is a serious omission. A few applications also give extremely small crown thicknesses, which do not seem to compare with the present railroad practice.

Yours truly,
Emile Low, M. Am. Soc. C. E.

Rome, N. Y., Nov. 6, 1905.

Concrete Floors and Stringers for Railway Track.

Sir: Referring to the article on "Concrete for Railway Bridges and Tracks," by J. W. Schaub, which appeared in your issue of Nov. 2, the writer would like to suggest that in the "standard roadway" it might be perfectly practical to replace that portion of the proposed roadway which is shown as 18 ins. of rubble concrete, by, say, 2 ft. of rock fill, which can be consolidated by filling the voids with sand and gravel, thoroughly wet down. This construction would probably be as permanent as, and certainly much cheaper than, the rubble concrete.

Further than this, it is not so clear that the longitudinal wood stringer is a useful or necessary part of the permanent roadway. It is entirely feasible to lay rails directly on longitudinal stringers of concrete to which they may be firmly attached at any desired interval by removable bolts and clips.

In the Akmeek copper mine, near Calumet, Mich., the General Superintendent, Mr. W. J. Uren, has introduced a system of longitudinal concrete stringers which are molded in place on the footwall of the shafts, which are at an angle of 42°. These are standard gage tracks laid

...h rails fastened at 3 ft. intervals by bolts and ... the stringers. The stringers are laid to grade ...face, so that the rails have a continuous bearing ...oncrete. The alinement of rails is perfect and as ... high rates of hoisting speed are attained.

...ian would be good for bridge floors and would ... be worth a trial on roadways in comparison ... Mr. Schaub's proposed roadway. With perfect ... and alinement, no particular elasticity or "give" ... tracks is necessary, since the cars and locomotive ... are entirely supported on springs. Street car ... as now built with rails on concrete have great ... In mining practice 10-ton ore skips on four ... wheels with rigid axles and without springs are ... 30 to 40 miles per hour.

... Schaub's plans, or some modification of them, may ... many cases rival the concrete tie.

J. F. Jackson, Assoc. M. Am. Soc. C. E.

Houghton, Mich., Nov. 6, 1905.

The Estimated Cost of a Concrete Substructure for Railway Track.

Sir: On p. 460 of your issue of Nov. 2, 1905, Mr. J. W. Schaub gives a section for a proposed permanent railway track with concrete substructure and no ballast, estimated to cost $14,000 per mile. The writer does not believe this estimate is correct.

Taking the dimensions shown on the drawing and the lowest safe figures for cost, the estimate should be as follows:

4,000 cu. yds. rubble concrete, at $5	$20,000.00
1,320 cu. yds. reinforced concrete, at $7	9,240.00
3,520 tie rods, at 35 cts.	1,232.00
10,560 lin. ft. sleepers, at 7 cts.	739.20
Total per mile	$31,211.20

If we use ordinary ballast and steel ties in lieu of the concrete and wood sleepers, we would have a practicable and essentially permanent track possessing all the elastic features necessary to unavoidable adjustments of line and surface.

The estimate for such a track would be as follows:

5,320 yds. ballast, at $1	$5,320.00
3,168 steel ties, at $2.50	7,920.00
Total per mile	$13,240.00

Such a quantity of ballast would render track on all ordinary and well settled roadbed practically independent of the action of the weather if properly drained, except, possibly, in some sections where the frost is very severe. In any event, the foundations for the concrete would have to go as deep as any ballast to get below the action of frost.

The difference in cost in favor of the ballast section is $18,451 per mile, the interest on which should maintain the track with steel ties on the heavy ballast section.

It is more than probable that the proposed permanent concrete section would not be nor remain immovable, due to the action of all the forces that put track out of line and surface; and it is quite evident that any adjustment of the concrete roadway or the track thereon would be very difficult and costly.

It is further quite probable that the concrete roadway could not be built in place for $5 and $7 per yard where it would be necessary to maintain the heavy traffic that must exist before any such expensive construction could be considered.

It is difficult to imagine how such construction could be put in satisfactorily and at reasonable cost except by diverting the traffic to a second track, and this, as a rule, would be out of the question on single track roads without great expense and costly interruption and delay to traffic.

Yours truly,

J. L. Campbell.

El Paso, Texas, Nov. 7, 1905.

A PIECE OF WOOD ANTEDATING THE GLACIAL PERIOD.

In the excavation for the foundation of a high office building near the lower end of Manhattan Island, there was uncovered a few days ago a piece of wood which undoubtedly formed part of a tree that must have grown before the ice age in geologic history.

The following letter narrates the circumstances under which the find was made:

Sir: In the process of excavating for the foundations of the United States Express Building at the corner of Rector and Greenwich Sts. in this city, we uncovered a piece of wood lying on top of the bed rock beneath a stratum of Hardpan and boulders. From the position in which this piece of wood was found it is evidently prehistoric, and is probably the oldest piece of wood in the world. The bed rock at this point is about 40 ft. below the curb. On top of the bed rock is a strata about 11 ft. thick, composed of hardpan and boulders. This strata is covered by ordinary quicksand and muck, usual in this section. The piece of wood was found on top of the bed rock embedded in and covered by the strata of hardpan. The accompanying blueprint sketch shows the relation of the different strata and the position in which the wood was found.

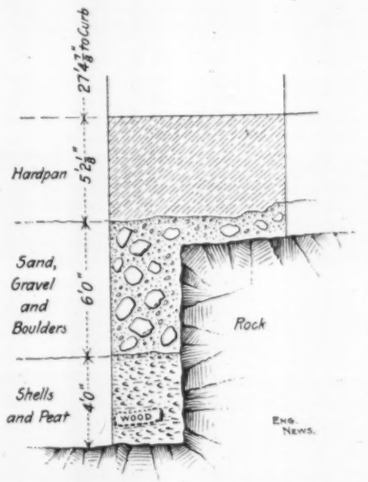
Very truly yours,

The Foundation Company,

Edwin F. Kellogg.

35 Nassau St., New York, Nov. 16, 1905.

We may note in this connection that the rock surface of Manhattan Island, as shown by a recent U. S. Geological Survey publication, slopes from the north toward the south, and passes below tide level at about 10th St. Below this point Manhattan Island is really a great sand and silt



Geological Section Below Alluvial Sand at Wall, Greenwich and Rector Sts., New York City, Showing Position in which Wood was Found Buried under Glacial Drift.

deposit, built up on the underlying rock by the tides and currents of recent geologic time. As stated above, beneath the more recently deposited sand and silt and next to the rock there is a layer of boulders, gravel and hardpan, which were evidently deposited during the glacial period.

Inspection by a member of our editorial staff of the piece of wood referred to shows it to be light brown in color and rather punky, as might be expected from its great age and long immersion. It retains, nevertheless, considerable elasticity. One would judge it to be of some soft wood species. It was doubtless waterlogged and immersed for a long period before it was finally buried in the glacial drift.

REGULATIONS FOR THE TRANSPORTATION OF EXPLOSIVES.*

General Notice.

The safe transportation of explosives is largely influenced by the manner in which they are made and packed for shipment, as well as by the careful and intelligent handling of them by railway employees. Information in regard to the kind of explosives is necessary so that railway employees may not ignorantly incur danger or endanger the lives and property of the public.

Shipments made by the United States Government† will be accepted upon the certificate of an army or navy officer or duly authorized non-commissioned or warrant officer, that the shipments are made in accordance with United States Government regulations, including limitations of weight, for which the form of certificate entitled "United States Government Certificate of Explosives Offered for Transportation," will be used and kept on file.

Other explosives, except such as are forbidden, will be received for transportation on the ..... Ry. on and after ....., 190... provided the following regulations are complied with, and provided their method of manufacture and packing, so far as it affects safe transportation, is open to inspection by the proper officer of this company.

Shipments of explosives destined to points beyond the lines of this company will only be accepted subject to the regulations of the roads over which the shipments are to be moved. Shipments offered by connecting lines will be received subject to the following regulations.

*These regulations were drafted by a committee of the American Railway Association and were approved by the Association at its Chicago meeting, Oct. 25, 1905. The report of a Board of Experts on the subject, which report was requested as a basis for the Regulations to be drawn up, was printed in our issue of Nov. 9.

†All the following regulations must be observed for Government shipments except as to packing and weights provided for other shipments.

Classification.

1. Explosives are divided into the following groups:

1. Forbidden Explosives.
2. Common Black Powder.
3. High Explosives.
4. Smokeless Powders.
5. Fulminates.
6. Ammunition.
7. Fireworks.

Group 1.—Forbidden Explosives.

2. Liquid Nitro-Glycerine, Dry Gun Cotton (except as made up in ammunition), high explosives containing over 60% of nitro-glycerine (except gelatine dynamite), and Fulminates in bulk in a dry condition, must not be accepted for transportation.

Group 2.—Common Black Powder.

3. Common Black Powder embraces all explosives having the constituents of ordinary gun powder or similar in composition. This group includes rifle, sporting, blasting, cannon and the prismatic powders.

Packing—Packages containing less than 20 lbs. of rifle, sporting, blasting, or cannon powders must be enclosed in a wooden box so that the filling holes of the packages will be up.

Prismatic powders must be packed in tight tin boxes, which must be enclosed in a wooden box.

Twenty pounds or over of Common Black Powder should be packed in a wooden keg or cask. Iron or steel kegs or casks will be received. These iron or steel kegs or casks must be so made and the filling hole so secured that, when filled with sand and dropped in any manner a distance of 4 ft. on a rail, they will not rupture, nor will any of the sand escape.

Weight—Packages containing over 115 lbs. net will not be received.

Marking—Each box, cask or keg must be plainly marked "COMMON BLACK POWDER."

Group 3.—High Explosives.

4. High Explosives are all explosives more powerful than ordinary black powder, except smokeless powders and fulminates. They are known under various trade names, such as Acme, Ætna, Atlas, Climax, Commercial, Dittmar, Dynamite, Forcite, Fumeless, Giant, Hecla, Hercules, Jovelte, Big Chief, Judson, Masurite, Samson, Rend-Rock, Rack-a-Rock, etc.

5. NO HIGH EXPLOSIVE CONTAINING OVER 60% NITRO-GLYCERINE WILL BE RECEIVED, EXCEPT GELATINE DYNAMITE. Explosives like Rack-a-Rock, one constituent of which is liquid, will be accepted if the liquid is not explosive and is not packed in the same boxes with the other constituent.

High explosives consisting of a liquid combined or mixed with an absorbent material must have the absorbent material properly dried before mixing and the ingredients uniformly mixed so that the liquid constituent is thoroughly absorbed. Explosives containing nitro-glycerine must have a satisfactory kind of antacid in the absorbent material equal to 1%, or over, of the weight of the latter.

Packing—High explosives must be made into cartridges and not packed in bags or sacks. Bags or sacks of Judson powder containing not over 12½ lbs. each, will be considered cartridges. The covering of the cartridges, consisting of paper or other material, must be so treated that it will not absorb the liquid constituent of the explosive. Boxes should be painted on the inside or lined with paraffine paper, or otherwise treated so that the liquid constituent of the explosive will not be absorbed by the wood.

The cartridges must be so arranged in the boxes that when they are transported all cartridges will lie on their sides and never on their ends.

The boxes must be strong and made of lumber not less than ½-in. in thickness, and with ends 1 in. in thickness, and not too large to be readily handled by one person.

Weight—Packages containing 50 lbs. net will not be accepted.

Marking—The boxes must be plainly marked on top and on one side or end "HIGH EXPLOSIVE—DANGEROUS." The position in which the cartridges lie in the boxes must also be indicated thereon.

Group 4.—Smokeless Powders.

6. Smokeless powders are those explosives from which there is little or no smoke when fired. This group consists of (A) smokeless powder for army and navy use; (B) smokeless powders, known also as wood powders, for rifle or shot-gun use in which gun-cotton or nitro-cellulose is the principal ingredient; (C) the picrate powders, such as Velox and Gold Dust, and (D) wet gun-cotton for torpedoes and army use.

7. (A) SMOKELESS POWDER for army and navy use.

Packing—Smokeless powders must be packed in tight wooden boxes free from knot holes or cracks.

Weight—Packages must not weigh over 115 lbs. net.

Marking—Each package must be plainly marked on top "SMOKELESS POWDER—KEEP FIRE AWAY."

8. (B AND C) SMOKELESS POWDER for rifle or shot-gun use.

Packing—Packages containing less than 10 lbs. must be enclosed in a wooden box so that the filling holes of the packages will be up.

Ten pounds or over should be packed in a wooden keg or cask. Iron or steel kegs or casks will be received. All kegs unless boxed must measure not less than 9 ins. in diameter and 10½ ins. in length or have equivalent contents. These iron or steel kegs or casks must be so made and the filling hole so secured that when filled with sand and dropped in any manner a distance of 4 ft. on a rail, they will not rupture nor any of the sand escape.

Weight—Packages containing over 115 lbs. net will not be received.

Marking—Each box, cask or keg must be plainly marked on top "SMOKELESS POWDER—KEEP FIRE AWAY."

9. (D) WET GUN-COTTON.

Packing—Wet gun-cotton must be packed in tight wooden boxes free from knot holes or cracks. These boxes must be so well constructed or the gun-cotton so enclosed in paraffine paper or other impervious material, that it will not dry out during transit so as to contain less than 15% of water upon its arrival at destination.

No gun-cotton is to be received for shipment unless it contains 20% of water.

Weight—Packages weighing over 220 lbs. gross must not be received.

Marking—Gun-cotton must be plainly marked on top "GUN-COTTON—WET."

Group 5.—Fulminates.

10. This includes FULMINATE OF MERCURY or other fulminates in bulk form—that is, not made up into percussion caps, detonators, blasting caps or exploders.

Packing—Fulminate of mercury in bulk must contain when packed not less than 25% of water and must in this wet condition be placed in a 12-oz. duck bag and securely tied. This duck bag must be placed in a rubber bag, which rubber bag must be filled with water and securely tied. The rubber bag and contents must then be placed in a tight cask, the empty spaces around the bag filled with sawdust, the cask closed and filled with water and then sealed.

Marking—Each cask must be plainly marked "FULMINATE—HANDLE CAREFULLY."

Group 6.—Ammunition.

11. Ammunition consists of three classes, small-arms ammunition and great-gun ammunition, both in the form of cartridges; and detonators, blasting caps, percussion caps, fulminators, exploders, etc.

12. Small-arms ammunition consists usually of a paper or metallic shell, which contains the primer, explosive and projectile, the materials necessary for one firing being all in one piece, to be used in sporting or fowling pieces or in rifle, pistol practice, etc.

Packing—Small-arms ammunition to be used in sporting or fowling pieces or in rifle and pistol practice, etc., must be packed in pasteboard or other boxes, and these pasteboard or other boxes must be packed in strong wooden boxs.

Marking—Each package or case must be plainly marked "AMMUNITION—HANDLE CAREFULLY."

13. Great-gun ammunition embraces all fixed ammunition in which the projectile weighs over 1 lb. and is usually transported only for government use.

Packing—This form of ammunition must be packed and properly cushioned in strong wooden boxes, small and light enough to be readily carried by not more than two men.

Marking—Each package or case must be plainly marked "GREAT-GUN AMMUNITION—HANDLE CAREFULLY."

14. Ammunition in other form than cartridges, such as detonators, blasting caps, etc., must be packed in strong, tight wooden boxes, and must not be placed near other explosives.

Marking—Each package must be plainly marked with the name of the article enclosed and the words "HANDLE CAREFULLY," as, for instance, "DETONATORS—HANDLE CAREFULLY," "PERCUSSION CAPS—HANDLE CAREFULLY," etc.

Group 7.—Fireworks.

15. Fireworks embrace everything that may be used to produce pyrotechnic effects. This group includes serpents, rockets, bombs, shells, mines, batteries, wheels, roman candles, maroons, fountains, quick matches, firecrackers, squibs for firework use, colored fires of all grades and every class of firework composition or exhibition pieces, and also torpedoes or track caps, fusees, fog signals, etc.

Packing—Fireworks must be securely packed in strong, tight wooden boxes in such manner that the ordinary shocks of transportation will not cause the articles to change position inside the box.

Marking—Each box or package must be plainly marked "FIREWORKS—HANDLE CAREFULLY—KEEP FIRE AWAY."

Selection and Preparation of Cars.

16. For the transportation of common black powder, high explosives, smokeless powders, fulminates and great-gun ammunition ONLY BOX CARS IN GOOD CONDITION, OF NOT LESS THAN 60,000 LBS. CAPACITY, MUST BE USED. STEEL UNDERFRAME BOX CARS ARE RECOMMENDED.

17. In all cases the cars must be as follows:

(a) Equipped with air-brakes and hand-brakes in condition for service.

(b) Must have no loose boards, or cracks in the roof, sides or ends.

(c) The doors must shut so closely that no sparks can get in at the joints, and if necessary must be stripped.

(d) The journal boxes and trucks must be carefully examined and put in such condition as to reduce to a minimum the possibility of hot boxes or other failure necessitating the setting off of the car before reaching destination. The car must be carefully swept out before it is loaded.

(e) Holes in the floor or lining must be repaired and special care taken to have no projecting nails or bolts or pieces of metal which may work loose and produce holes in packages of explosives during transit.

(f) Short pieces of hard wood, 2-in. plank, must be spiked to the floor over the king bolts, or draft bolts, to prevent possibility of their wearing through the floor and into the packages of explosives.

(g) Agent or inspector must examine cars and sign "Certificate of Inspection of Car Containing Explosives" upon the prescribed form before permitting the cars to be loaded or dispatched. The certificate must also be signed by the shipper.

18. Small-arms ammunition, detonators, etc., and fireworks must be loaded in a box car in good condition, so tight as to prevent the entrance of sparks into the car. Cars containing small-arms ammunition, detonators, etc., and fireworks do not require the "Certificate of Inspection of Car Containing Explosives," but cars containing fireworks should be carded "Inflammable—Keep Lights and Fires Away." The shipper of these articles must execute and deliver to the station agent the "Manufacturer's Certificate," or the "Shipper's Certificate" upon the prescribed form.* The station agent must make the proper note upon the billing to show that he has the certificate on file.

Placarding of Cars and Certification of Contents.

19. The prescribed forms of cards and certificates must be used.

20. Every car containing Common Black Powder, High Explosives, Smokeless Powders, Fulminates or Great Gun Ammunition, in any quantity, must be plainly carded on both sides and both ends "EXPLOSIVES—HANDLE CAREFULLY—KEEP FIRE AWAY."

The agent will be held responsible if a car containing these explosives leaves his station or a siding within his jurisdiction without having these cards properly affixed.

21. Manufacturers shipping common black powder, high explosives, smokeless powders, fulminates and great-gun ammunition, and shippers of great-gun ammunition in carloads or less than carloads, will be required to properly fill out and sign the "Manufacturer's Certificate of Contents and of the Method of Packing and Marking Packages of Explosives" for each shipment on the prescribed form, which, when signed in writing, must be delivered to the station agent.† All other shippers shipping common black powder, high explosives, smokeless powders, fulminates and great-gun ammunition, must sign in writing the "Shipper's Certificate of Explosives Offered for Transportation" on the prescribed form, covering the words "These explosives are in the original packages as manufactured," which form must be delivered to the station agent.

Shippers must procure the prescribed forms of certificates and cards from the station agent.

The agent on receipt of the Manufacturer's or the Shipper's Certificate‡ must endorse the back of the card waybill and revenue way-bill to show that this certificate has been duly executed and filed; thus:

> Certificate covering this property duly executed and filed at this (.....) Station. .....19..

The "Manufacturer's Certificate" or the "Shipper's Certificate"‡ will be filed by the station agent at the station at which the shipment originated.

*The "United States Government Certificate of Explosives Offered for Transportation" must be used for shipments made by the Government.

†The United States Government when shipping common black powder, high explosives, smokeless powders, fulminates and great-gun ammunition, will be required to properly fill out and sign the "United States Government Certificate of Explosives Offered for Transportation," for each shipment on the prescribed form, which when signed in writing must be delivered to the Station Agent. (See General Notice.)

‡The "United States Government Certificate of Explosives Offered for Transportation" will be used for shipments made by the Government.

Shipments from Connecting Lines.

22. Agents at junction points may receive and forward cars carded as prescribed in Rule 20 as containing explosives, from connecting lines known to have complied these regulations, without the "Manufacturer's Certificate" or "Shipper's Certificate"‡ and without the Certificate of Inspection of Car Containing Explosives being presented; but these certificates must be furnished to the receiving road when requested.

Agents when in doubt as to whether the lading is properly stowed or not will inspect the contents to ascertain the condition of the lading.

Handling of Explosives.

23. In handling packages of explosives at stations and in cars, the greatest care must be taken to prevent their falling or getting shocks in any way, and they must not be thrown nor dropped, but must as far as practicable be passed from hand to hand, or carried by one or more persons, and must not be rolled on the platform or car floor, nor handled on trucks, unless they are so heavy that this cannot be avoided. The agent must choose careful men to handle explosives, must see that the platform and the feet of the men are free as possible from grit, and must take all possible precautions against fire. No unauthorized persons must have access to the explosives at any time while they are on the property of the Company. Should any package of high explosives when offered for shipment show excessive dampness or be mouldy or show outward signs of any oily stain or other indication that absorption of the liquid part of the explosive in the absorbent material is not perfect, or that the amount of the liquid part is greater than the absorbent can carry, THE PACKAGES MUST BE REFUSED IN EVERY INSTANCE AND MUST NOT BE ALLOWED TO REMAIN ON THE PROPERTY OF THE COMPANY.

Loading in Car.

24. Boxes of High Explosives must be so loaded in the car that the cartridges will be on their sides and never so that the cartridges will be on end.

All other boxed explosives must be loaded with the boxes top side up. Explosives packed in round kegs, except when boxed, must be loaded on their sides in rows across the car if there is more than one tier.

Larger casks, barrels or drums may be loaded on their sides or ends as will best suit the conditions. Whatever the kind or form of the packages, after they are loaded THEY SHALL BE SO STAYED THAT THEY CANNOT CHANGE POSITION UNDER THE ORDINARY SHOCKS OF TRANSPORTATION. Special care must be used so that they cannot fall to the floor or have anything fall on them during transit.

25. Black powder, high explosives, and smokeless powder of all kinds, may be loaded together in the same car. Fulminate, ammunition, both small-arms and great-gun, and detonators, etc., and fireworks must never be loaded with each other, nor in the same car with common black powder, high explosives, or smokeless powder. All kinds of fireworks may be loaded together in the same car.

26. "Friction Matches" or other articles of like nature, acids, chemicals, gasoline, naphtha, benzine, etc., must not be loaded in the same car with common black powder, high explosives, smokeless powders, fulminates, great-gun ammunition or fireworks, nor when unloaded be put near those explosives. Care must be taken that other freight in the car is so loaded and stayed that there is no danger of the packages of explosives being broken during transit.

Safety Fuse and Safety Squibs.

27. Safety fuse and safety squibs will be accepted for shipment at any time they are offered, and the restrictions in regard to shipping powder do not apply to them. Thes articles, provided they are properly boxed, may be loaded in the same car with other explosives.

Handling Cars Containing Explosives.

28. The following rules must be observed by yard and train employees in the making up and movement of freight trains and the handling of cars carded as containing explosives.

(a) Cars carded as containing explosives must not be hauled in a train carrying passengers.

(b) The conductor must under no circumstances take a car containing explosives from a station, including transfer stations, or a siding unless it is properly carded as per Rule 20, and unless the car appears in first-class condition.

The conductor must in all cases notify the enginemen and trainmen that a car containing explosives is on the train and where it is in the train before leaving the initial station.

Conductors must frequently inspect such cars to see that the carding is intact. When any of these cards become detached or lost in transit, the conductor will give notice thereof on arrival at the next Division Terminal Yard, to the Yardmaster or other person in charge, who must attend at once to recarding the cars as required.*

*It is recommended by the Committee that all waybills for shipments of explosives be stamped "Explosives," or that a special card be attached to the waybill showing the nature of the shipment.

At points where trains stop, trainmen must examine cars carded as containing explosives and adjacent cars to see if they are in good condition and free from hot boxes or other defects liable to cause damage. If cars set off short of destination from any cause, the conductor must notify the nearest agent, who must see that every precaution is taken to prevent accident. The conductor must also notify the Superintendent from the first telegraph office.

A car carded as containing explosives must be placed as near center of train as possible, and when practicable, not closer than fifteen (15) cars from the engine or ten (10) cars from the caboose, unless length of train will not permit,* and must have its air-brake and hand-brakes in service and be placed between cars with air-brakes in service. It must be placed between two box cars in good condition not loaded with oil or other inflammable material, lumber, iron, pipe or other articles liable to break through end of car from rough handling. Cars containing explosives must not be placed in a train within five cars of each other, and not more than three such cars placed in any one train.

(e) HANDLING IN YARDS—In handling cars carded as containing explosives in yards or placing on sidings, they must, when practicable, be coupled to the engine protected by a car between, and the car not cut off while in motion. It must be known that the hand brakes are in good condition. Other cars must not be allowed to strike a car carded as containing explosives. They should be so placed in yards or on sidings that they will be subject to as little handling as possible and removed from all danger of fire.

29. AGENTS AT DESTINATION AND TRANSFER STATIONS MUST SEE THAT THE CARDS PRESCRIBED IN RULE 20 ARE REMOVED FROM CAR AS SOON AS THE EXPLOSIVES ARE UNLOADED.

30. Agents must furnish all the shippers of explosives within their territory with copies of these regulations.

In Case of a Wreck.

31. In case of a wreck involving a car containing explosives, the first and most important precaution is to prevent fire. Although most of the group, "high explosives," will burn in small amounts quietly, and without causing a disastrous explosion, yet it must be remembered that it is the characteristic of most explosives to burn, and consequently everything possible must be done to keep fire away. Before beginning to clear a wreck in which a car containing explosives is involved, all unbroken packages should, if possible, be removed to a place of safety, and as much of the broken packages as possible gathered up and likewise removed. Furthermore, it should be borne in mind that "high explosives" are readily fired by a blow, and all explosives, except when they are wet, by the spark produced when two pieces of metal or a piece of metal and a stone come violently together. In clearing a wreck, therefore, care must be taken not to strike fire with tools, and in using the crane or locomotive to tear wreckage in pieces, the possibility of producing sparks must be considered. With such explosives as "common black powder," "smokeless powder," and "fulminates" thorough wetting with water practically removes all danger of explosion by fire, spark or blow; but with the "high explosives" wetting does not make them safe from blows. With all explosives, mixing with wet earth renders them safer from either fire, spark or blow. In case "fulminate" has been scattered by a wreck, the ground involved after the wreck has been cleared, must be saturated with oil. If this is not done, when the ground and fulminate get dry, small explosions will constantly occur whenever the mixed material is trodden on or struck.

*This applies to cars in the ordinary current of traffic on main lines. For movements on branch lines, equivalent to switching movements, such special regulations should be made by each road as will suit the conditions of the service.

ANNUAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The thirteenth general meeting, and one of the most successful meetings ever held, of the Society of Naval Architects and Marine Engineers, took place in New York City on Nov. 16 and 17. About 150 members were in attendance, but the number in the meeting room was seldom more than a third of this number. On the whole, however the papers received ample consideration. The meeting closed with a banquet, at which there was a number of important guests, and with an excursion to the Curtis turbine works of the General Electric Co., at Schenectady, N. Y.

BUSINESS PROCEEDINGS.—The address of the President, Admiral Francis T. Bowles, was brief and called attention only to the unsatisfactory condition of shipbuilding. Except on the Great Lakes the record of the year has been one of serious depression.

The report of the Secretary-Treasurer showed the Society to have on Nov. 15, 866 members of all classes. The total receipts of the Society for the year were $9,200.60 and the total expenditures were $9,611.32.

A number of amendments to the constitution were voted on and passed. These amendments provide that the officers of the Society shall consist of a President, Past President, twelve Vice-Presidents, 24 members of council, and a Secretary and Treasurer; they also stipulate the time of office and methods of election. Among other stipulations is one that the President shall not be elected his own successor, and that his term of office shall be three years. Vice-Presidents will hold office for six years and members of council for three years.

TECHNICAL PROCEEDINGS. — The program comprised 18 papers; these were all read and discussed. In this report selection has been made of the papers of most general engineering interest for extended consideration; the remaining papers of special or local interest are presented simply by titles. The selection, it need

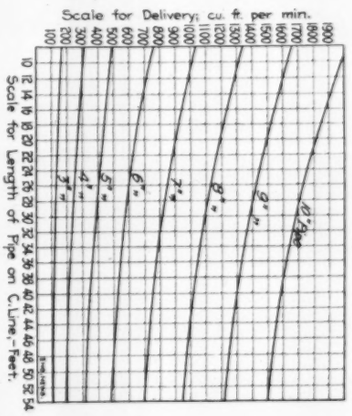


Fig. 1. Diagram for Determining Diameter of Branch Pipes in Ventilating System.

hardly be noted, indicates relative importance only in the sense noted, for example the voluminous paper on Methods of Conducting Speed Trials deserves high rank in its special field, but is of comparatively small interest to the general practitioner.

EXPERIMENTS WITH VENTILATING FANS AND PIPES.—This paper, by D. W. Taylor, U. S. N., gave the results from and described the method of conducting an extended series of experiments on ventilating fans and pipes at the Experimental Model Basin at Washington, D. C. The results, so far as they had been ascertained a year ago, were outlined by Mr. Taylor in a paper contributed to Engineering News of Nov. 3, 1904. Mr. Taylor's paper before the Society brought the account of the experiments up to date. So far as the pipe experiments go, Mr. Taylor summarizes the final results in the following set of conclusions:

The conclusions and instructions which may be drawn from the preceding experiments are briefly summarized below:

(1) Angles of Branches.—For the general run of branches make the angle anything less than 45°; 30° is a very good angle to use, but it is not necessary to adhere to it rigidly. For branches at the extreme end of the main, where the velocity is very much reduced, the branch angles should be increased and the last branch should generally lead off at 90°.

(2) Elbows in Branches.—For one 90° elbow add 3 ft. to the length of the branch; for two, add 7 ft., and for three, add 10 ft. For elbows less than 90° add in proportion. This applies to elbows whose radius to the center of iron pipe is 1½ diameter. A smaller radius should not be used.

(3) Outlet from Branches.—Connect the branch with its outlet fitting by a cone expanding 1½ ins. to the foot, making its diameter such that the air velocity at discharge will be 1,000 ft. per minute.

(4) Mains.—Use round mains wherever practicable. Make the standard conditions at the first outlet 5 lbs. pressure, and 2,000 ft. per minute velocity. As the branches lead off do not change the size of the main until sufficient air has been removed to reduce the velocity to a value between 1,200 and 1,500 ft. per minute. Then contract the main with a taper of 1½ ins. to the foot until the area is so reduced that the velocity again becomes 2,000 ft. per minute. Repeat the contraction wherever necessary, but do not reduce the final diameter of the main to less than twice the diameter of the last branch.

(5) Branchs, Sizes of.—From the layout of the system we know for each outlet the delivery required and the length of branch corrected for elbows. Then determine the size or inside diameter of the branch from Fig. 1. For branches leading from the main, where the head is materially below standard, determine the proper enlarged delivery which would take place under standard conditions, as explained above;* and from Fig. 1 determine the proper size of branch corresponding.

(6) Rectangular Pipes.—While experiments were not made with rectangular branches or mains, which should be avoided wherever practicable, it is thought that where such mains are under standard conditions Fig. 1 can be used for deliveries. For loss of head the formula for a square main is the same as for a round main.* For a rectangular main of short side h and long side nh, the formula to be used for loss of head is

$$H_f = \frac{l+n}{n} \frac{l}{h} \frac{v^2}{22{,}500{,}000},$$

where l is length of pipe and v velocity of air through it in feet per minute, H_f being the loss of head in feet of air due to friction.

The experiments on ventilating fans that were recorded by Mr. Taylor are as yet incomplete. From them the ventilating fans of commerce seem to show an actual efficiency in the neighborhood 50%, with sporadic exception.

The discussion on this paper turned largely on the reliability of the Petot tube as an indicator, and it consisted largely in quoting experience and opinion pro and con, and is not given. The main results of the tests in respect to pipe design were not questioned, and although some dispute arose over the low efficiency credited to commercial fans, it was conceded by several manufacturers present that the figure given was not far from correct. It was contended by them, however, that more efficient fans could be designed for special purposes if the purchaser were willing to pay for them.

TESTS OF MODEL PROPELLERS.—Two papers, one by Prof. W. F. Durand, entitled Experimental Researches on the Performance of Screw Propellers, and one by Messrs. A. V. Curtis and L. F. Hewins, entitled Some Results of Tests of Model Propellers, were read and discussed together. The second paper described the results of the continuation of the series of tests inaugurated at the U. S. Experimental Model Basin, and described by Mr. D. W. Taylor at the meeting of the Society for 1904. Tests were made on 24 four-bladed, 9 two-bladed, 8 six-bladed and 2 special three-bladed 16-in. diameter wheels. Referring to the four-bladed wheels the authors say:

For propellers of the same width the power absorption coefficient increases rapidly with decrease of pitch ratio, also comparing propellers of the same pitch for the smaller pitch ratios the narrow blades absorb more power at low slips than the wide blades, but as the slip increases the wide blade gradually become more effective and absorb somewhat greater power than the narrow ones. In the larger pitch ratios the wider blades absorb slightly more power throughout the range of slips. The maximum efficiency remains high, and occurs at lower slips as the pitch ratio and width of blade decrease. These features are thoroughly in accord with the re-

*As it is impossible to avoid loss of total head along the duct, with resulting loss of delivery from the standard, it is necessary to find some method of making up the discharge.

The formula for loss of head in a round or square pipe is

$$H_f = 4\, f \frac{l}{d} v_1^2,$$

where H_f is loss of head in feet of air due to friction, f is the coefficient of friction, l and d are length and diameter of the pipe, both expressed in feet, or both in inches, and v_1 is the velocity of flow thrpugh the pipe in feet per second. If we change v_1 to v, or velocity in feet per minute, and give f its proper value for first-class piping, namely, .00008, we have upon substituting and reducing,

$$H_f = \frac{l}{d} \frac{v^2}{11{,}250{,}000}.$$

If v = 2,000

$$H_f = .3556 \frac{l}{d}.$$

If

$$v = 1{,}000 \quad H_f = .0889 \frac{l}{d}.$$

Using this formula, knowing everywhere the size of a main and the discharge at each outlet, we can calculate the head at each outlet as compared with standard total head of 84.27 ft. Each foot of head lost means a loss of about 0.6 of one per cent. of delivery as compared with standard conditions. Suppose, for instance, at an outlet where 384 ft. per minute are needed the total head is 69.27, a loss from standard of 15 ft. The corresponding loss of delivery is 9% and the actual delivery to be expected will be only .91 of the standard delivery. Then the standard delivery would be $\frac{384}{.91} = 400$ cu. ft. per minute, and if the outlet is made of the size from Fig. 6 to pass 400 ft. under standard conditions, it may be expected to give the required 384 ft. under actual conditions.

sults found for the three-bladed propellers, and their truth would seem to be well assured. In discussing the former results attention was called to the fact, that even at the higher slips and with propellers of large pitch ratio, the power absorbed was not anywhere near in proportion to the widths of the blades, and with similar four-bladed propellers working under the same conditions, this fact is also very pronounced. Again, with the three-bladed propellers the maximum efficiency fell steadily off as the pitches decreased, showing that the highest maximum efficiency attainable occurs at a pitch ratio greater than 1.5. With the four-blade wheels the highest maximum efficiency falls below the pitch ratio 1.5 for all but the widest blades.

Tests of two-bladed propellers were made (1) on those of constant width ratio 0.2 and varying pitch, and (2) on those of constant pitch ratio 1.0 and varying widths. Referring to the first condition, the most notable feature is the extremely high efficiency of 84% obtained with the largest pitch ratio of 1.5. In the second case the tests show the narrowest blade wheel to be the most efficient of the series and "lead one to suspect that had a propeller been tried with the same narrow blades and a pitch ratio of 1.5 it might have proved to be even higher in efficiency." As in the three and four-blade wheels the power absorbed does not increase in proportion to the width of the blades. In the six-bladed wheels of mean width ratio of .125 and .200 respectively, for the higher pitch ratios the wider blades absorb slightly more power at all slips, while for the smaller pitch ratios the narrow blades absorb from 30 to 40% more power than the wider blades. The efficiency of the narrow blades is greater than that of the wider blades, and the maximum efficiency occurs at a lower slip.

The tests made by Prof. Durand cover the performance of 49 model propellers and were carried out in the canal of the hydraulic laboratory of Cornell University. The diameter of all propellers was 12 ins. and the diameter of the hub 2.4 ins. The shape of all blades was elliptical, the maximum width in tenths of the radius being expressed by the area number. The results for efficiency are shown in Table I. from Prof. Durand's paper. The author's comments on these results are as follows:

TABLE I.—Showing Efficiency Results of Model Propellers Tested at Cornell University.

Pitch ratio.	Slip ratio.	Area ratios 0.18	0.27	0.36	0.45	0.54	0.63	0.72
.9	.10	.59	.65	.65	.62	.62	.61	.60
	.20	.66	.68	.68	.69	.66	.65	.64
	.30	.66	.68	.66	.66	.64	.61	.60
	.40	.62	.61	.62	.61	.60	.59	.56
1.1	.10	.63	.63	.63	.65	.65	.63	.58
	.20	.70	.70	.69	.70	.70	.66	.62
	.30	.70	.68	.68	.67	.65	.62	.59
	.40	.66	.64	.63	.62	.59	.57	.56
1.3	.10	.51	.54	.55	.59	.61	.64	.65
	.20	.66	.68	.69	.68	.68	.69	.69
	.30	.68	.68	.68	.66	.66	.66	.66
	.40	.66	.65	.62	.61	.60	.60	.59
1.5	.10	.47	.56	.61	.60	.61	.61	.62
	.20	.65	.71	.69	.69	.69	.71	.71
	.30	.71	.72	.72	.69	.69	.68	.68
	.40	.68	.69	.66	.64	.63	.62	.60
1.7	.10	.50	.58	.61	.63	.63	.64	.65
	.20	.73	.73	.72	.71	.70	.70	.70
	.30	.72	.73	.72	.70	.70	.68	.68
	.40	.70	.69	.66	.64	.64	.63	.63
1.9	.10	.46	.56	.62	.63	.61	.62	.59
	.20	.67	.71	.74	.73	.71	.71	.69
	.30	.70	.73	.73	.73	.70	.69	.69
	.40	.65	.67	.67	.66	.64	.63	.63
2.1	.10	.52	.58	.61	.59	.61	.61	.61
	.20	.70	.69	.68	.69	.68	.68	.70
	.30	.74	.73	.70	.69	.69	.69	.69
	.40	.68	.64	.64	.63	.62	.62	.64

The efficiency relations shown in Table I. are of high interest and the general laws indicated will repay careful attention. The general character of the variation of efficiency with slip for a given propeller is well known and is indicated by the figures of the table. The values are low for low slip, rising rapidly to the maximum in the neighborhood of 20 to 30% and then falling more gradually as the slip increases beyond such value. In general there is indication that the propeller of very small area reaches its best efficiency at a relatively high slip, usually in the neighborhood of 30%, while that of large area reaches its best value at about 20% or below. The highest values seem furthermore to be only slightly dependant on either area or pitch ratio. The low pitch ratio with high area, as would be expected, shows the lowest values of the efficiency. Outside this territory all the propellers reach at some value of the slip a value of the efficiency closing approximately to 70, the best general results being indicated for fairly high pitch ratios and moderate areas.

Stated otherwise, these general efficiency relations indicate for a low slip, such as 10%, a general increase of efficiency with area, except for the lowest pitch ratios when such increase is followed by a decrease for the highest areas. For higher values of the pitch ratio and low slip, however, there is, as a rule, first a marked and then a slow increase of efficiency with increase in area, the best results being given for area ratios of 35 to 45. On the other hand, for high values of the slip, such as 40%, there is, as a rule, a continuous though perhaps slow decrease of efficiency with increase of area throughout the range. Intermediate between these extremes we find for moderate or average values of the slip btween 20 and 30% but slight change of the efficiency with area. For the lowest pitch ratio, however, the decrease of efficiency with area for these intermediate values of the slip is still well marked. It appears, therefore, that if values of the pitch ratio below 1 are employed, the propeller should be so proportioned as to work with a small area and high slip. On the other hand, for propellers lying within the more common ranges of pitch ratio and area, and operating at values of the slip between 20 and 30%, it appears that the efficiency will vary but slightly over the entire mid-field range thus indicated, and that any proportions corresponding to operation within these general limits may be freely chosen without fear of any important drop in the efficiency below the upper limits of 68 to 70%.

The character of these two papers was such as permitted of very little extemporaneous discussion, and the few speakers who took the floor gave very little further information.

CRUISER DESIGN.—In a paper entitled the Cruiser, Commander William Hovgaard, Royal Danish Navy, gave a historical review of the development of the cruiser and advanced arguments in favor of the development of very heavy high-speed vessels which he termed battleship-cruisers. The author's summary and conclusions were as follows:

We have seen from the historical review how the development of cruisers has been controlled largely by regard to war on commerce. It has been pointed out that the primary object of naval warfare is to break the naval military power of the opponent, in order thereby to obtain control of the ocean, since such control carries with it the attainment of all other desired objects, also control of commerce. This latter object must, therefore, be secondary, as far as naval operations are concerned, even although it may in some cases be of vital and, therefore, primary importance to the country. The shipbuilding policy should follow the same lines, first providing cruisers suitable for military service and, secondly, for commerce protection or commerce destroying. To reverse this order of precedence can only be done to the detriment of the general usefulness of a navy.

This policy, being based on fundamental strategical principles, should be followed by all countries.

For a country like the United States, which has little commerce on the ocean to protect, and to whom the inconclusive and barbarous method of warfare, called commerce destroying, is not likely to appeal, it appears that the shipbuilding policy should be directed exclusively towards purely military objects.

By an analysis of the duties which belong to cruisers in a war between military navies, it should be determined which of these duties are the most important, and on basis of these the proposed types of cruisers should be chosen. This is what has been done in the paper, with the result that a few types appear to be sufficient for all strictly military duties, viz. (see plate):

(1) Battleship-cruisers, of same military strength as ordinary battleships, but of higher speed. (About 2,000 tons, 21 knots.)

(2) Scouts of extreme speed, great endurance, perfect sea-going capability, and light armament. (About 5,000 tons, 25 knots.)

(3) Small cruisers of moderately high speed, fair endurance, relatively powerful armament and protection. (About 3,000 tons, 20 knots.)

The two first types are required only in small number, the last type in greater number.

The building of other special types, not perfectly suited to the primary service of a navy, implies reduced military strength and increased expenditure, and should be adopted only where absolutely necessary.

The present type of first-class cruiser (Tennessee, Minotaur and Edgard Quinet), although useful in many cases, does not seem indispensable for any particular service, and is ill suited for its most important duty, participation in fleet actions, and it should, therefore, be abandoned.

Second class cruisers appear to be useful or necessary only to those navies which, like the English, have a great ocean trade to protect.

For a navy like that of the United States it would, therefore, seem unnecessary and uneconomical to multiply cruiser types beyond the three here proposed.

In discussion of the paper Mr. W. D. Taylor referred particularly to the contention made by the author that the armor should be put on the sides and not into a protective deck. This he considered was certainly the correct theory of armoring, and was the one followed in the U. S. Navy. Admiral Francis T. Bowles spoke [illegible] defense of cruisers of the "Tennessee" class [illegible]tioned by the author. He considered that it [illegible] be borne in mind that cruisers did not [illegible] meet ships of the latest design. The "Tenn[illegible]" by her superior speed could choose her foe[illegible] could also engage a very large proportion of [illegible]m. The Russian-Japanese war had indicated s[illegible]ral changes: The value of speed was much g[illegible]ter than had been supposed, and the value of [illegible]il-ness was not so great as had been supposed. He thought that if officers would give up the [illegible]m much might be gained in speed. Mr. Hora[illegible]ee agreed with the author as to battleship-cr[illegible]rs and as to the reduction of deck armor. H[illegible]le-scribed at length a new type of war vesse[illegible]o-posed by himself, the characteristic featu[illegible]of which were very low freeboard and an arm[illegible]t of a few very heavy guns in a single turret.

COMPARISON OF RECENT BATTLESH[illegible]S.—A paper by Mr. H. G. Gillmor, U. S. N., g[illegible] a comparison in detail of six recent battleshi[illegible]s-signed for the American, English, Japanese[illegible]r-man, Italian and French navies. As showi[illegible]e main characteristics of the latest fighting [illegible]ps of the line, Table II. is taken from Mr. Gil[illegible]'s paper. His discussion of minor comparative [illegible]e-tails is of special rather than general interest.

LONGITUDINAL BENDING MOMENTS IN LAKE STEAMERS.—This paper by Mr. W. D. Babcock presented the results of calcul[illegible]ns made by the author to determine the maximum bending moments, assuming a wave 200 ft. long and 20 ft. high, on the Lake steamer "Victory," 380 ft. long; on the same vessel increased in length to 542 ft. by adding 72 ft. amidships, and on the steamer "Elbert H. Gary," 549 ft. long. Summarizing the author says:

From the calculations we observe that the maximum hogging moment is about 21,800 foot tons for the original ship and 26,700 foot tons for the lengthened ship, an increase of about 22½%. The maximum sagging moment is 41,400 foot tons for the original and 40,000 foot tons for the lengthened ship. In any position which this vessel is ever likely to assume among waves it is fair to believe that the sagging moment will always be considerably in excess of the hogging moment.

For purpose of comparison with the curves of the "Victory," similar calculations have been made on the steamer "Elbert H. Gary," which is one of four sister ships which are now the largest in service on the lakes. The maximum sagging moment for the loaded ship in still water is 40,700 foot tons, or $1/_{200}$ the product of the length and displacement. For the various waves shown the maximum hogging moment is 40,200 foot tons ($1/_{200}$) and the maximum sagging moment is 97,500 foot tons ($1/_{84}$).

As an example of the latest boats the steamer "Elbert H. Gary" of the fleet of the U. S. Steel Corporation may be described. This ship is 569 ft. over all, 549 ft. keel, 56 ft. beam, and 31 ft. deep. She has a triple expansion engine 24, 39 and 65 by 42 ins., and two Scotch boilers 15 ft. 4½ ins. diameter by 11 ft. 6 ins. long, and with 10,500 tons cargo on a draught of 19½ ft. makes 12 miles per hour with about 2,000 IHP. The cargo has been loaded in 4 hours and 30 minutes and taken out in 4 hours and 10 minutes. This boat has 34 hatches, fitted with telescopic covers made of steel plate and opened and closed by three special engines on deck through shafting, clutches and chains.

The discussion on this paper drifted into the question of the suitability of the Great Lakes types of vessels for ocean coastwise service, and brought out little of value.

MARINE STEAM TURBINES.—Two papers, one by Mr. Chas. G. Curtis, entitled Marine Ap-

TABLE II.—COMPARISON OF RECENT BATTLESHIPS OF DIFFERENT NATIONS.

	"Vermont."	"Lord Nelson."	"Katori."	"Deutschland."	"Vittorio Emanuele."	"Democratic."
Length between perpendicular, ft.	450′	410′	420′	398′—6″	435′—6″	438′—6″
Breadth, molded, ft., ins.	76′—10″	79′—6″	78′	72′—9″	72′—6″	79′—6″
Draft, mean: ft., ins.	24′—6″	27′	27′	24′—6″	27′—3″	27′—6″
Displacement, in tons	16,000	16,500	15,950	12,997	12,624	14,635
Indicated H.P. with forced draft	16,500	16,750	16,000	16,000	19,000	18,000
Speed, in knots, " " "	18.0	18.0	18.5	18.0	22.0	18.0
Armament:—						
Main battery	4—12″ 8—8″ 12—7″	4—12″ 10—9.2″	4—12″ 4—10″ 12—6″	4—11″ 14—6.7″	1—12″ 12—8″	4—12″ 10—7.6″
Secondary battery	20—3″ 12—3 pdrs. 8—1 pdrs.	37 small	10—12 pdrs. 3—3 pdrs. 6—M.	22—3.4 4—1.4″ 4—M.	12—3″ 12—1.8	26—1.8″ 2—1.4″
Torpedo tubes:—						
Above water	....	....	....	....	....	3
Submerged	4	4	5	6	2	2
Armor:—						
Length of water-line belt	Whole length	Whole length	Whole length	Whole length	Whole length	Whole length
Thickness of water-line belt at amidship, ins.	9″	12″	9″	9.5″	9-3/4	11″
Thickness of water-line belt at end, ins.	4″ 7″	6″, 4″	5″ 6″	4″ 6″	4″ 6″	7″ ....
Bulkhead, ins.	2/3 length	3/4 length	2/3 length	3/5 length	1/2 length	Whole length, narrow
Length of upper belt	7″	8″	6″	8″	7.8″	8″
Thickness of upper belt, ins.	12″, 8″	12″	10″	10″, 6″	8″	12″
Protection, largest guns, ins.	6-1/2″, 6″	8″	6″	6-1/2	6″	8″
Protection, medium caliber guns, ins.	900	900	750	700	1,000	900
Coal supply, normal, tons	2,200	2,500	1,800	1,800	2,000	1,820
Coal supply, bunkers full, tons						

...s of the Curtis Steam Turbine, and the ... Mr. E. M. Speakman, entitled Marine ... Turbine Development and Design, were ... Mr. Speakman's paper will be pub... early in full in a future issue. The fol... extract from Mr. Curtis' paper describes ... largest vessels to which the Curtis ... has been applied up to date:

...re River Shipbuilding Co. is now building two ... turbine vessels. One of these is the U. S. scout ... "Salem" and the other is the Southern Pacific ... "Creole."

	Salem.	Creole.
Le... L. W. L.	420 ft. 0 ins.	415 ft. 8 ins.
Br...	46 " 8 "	53 " 0 "
Dr...	16 " 9½ "	25 " 0 "
Dis...ment tons	3,750	10,160
Ho...power	16,000	8,000
Speed, knots	24	16

In both vessels there are two shafts and two screws with complete independent turbines on each shaft. In the case of the "Salem" the proposed revolution of the screw at 24 knots is 350; in the case of the "Creole" somewhere between 225 and 275. The space occupied by the turbines fore and aft (including the reversing mechanism) is only about half that occupied by the equivalent triple or quadruple expansion four cylinder engines and the weight is considerably less. In the case of the "Creole" the weight of the two turbines is, roughly speaking, about half of that of the equivalent quadruple expansion engine. The total saving in weight of the engines, shafting, propellers, etc., is very considerable. Each turbine is in the form of a drum shaped shell, built up in sections, having an outside diameter of about 11 ft. and an overall length of about 14 ft. Each turbine comprises 7 stages for going ahead and two stages for reversing. There is no end thrust due to the pressure of the steam in the turbine itself and and the propeller thrust is taken up by the ordinary thrust block external to the turbine.

During the past summer the Vulcan Shipbuilding Co. of Germany completed a turbine vessel called the "Kaiser," which is fitted with two shafts and two independent turbines of this type. The turbines were built for the Vulcan Works by the Allgemeine Elektricitats Gesellschaft, of Berlin, who are licensees under the Curtis Turbine Patents, and were designed by and built under the very able direction of Mr. O. Lasche, the technical director of the turbine works of the company. The performance of these turbines and of the vessel on her trial trip was admirable, and reflects great credit upon Mr. Lasche and his associates, and also the designing engineers of the Vulcan Works, who assumed the responsibility of getting efficient screw action under the unusual conditions. The guarantees were intended to represent the performance of a first class 4-cylinder triple expansion engine and the ordinary slow turning screws which necessarily have a somewhat higher efficiency than the comparatively high revolution screws requisite for turbine propulsion. The actual figures guaranteed were a speed of 19½ knots, and a consumption during a 6-hour run of not over 4,700 kgs. of coal per hour, including all auxiliaries. Progressive speed trials were had up to 20.46 knots, the propellers turning at 655 revolutions per minute. During a 6-hour run 20 knots was averaged on 4,000 kgs. of coal per hour. The dimensions of the vessel are as follows:

Water line length, 310 feet.
Beam, 38.2 feet.
Draft on trial trip, 0.74 feet.
Displacement, 1,800 tons of 2,240 pounds.

MISCELLANEOUS PAPERS.—In a paper entitled The Ultima—a Globular Naval Battery, Mr. Anson Phelps Stokes described the latest design of the floating battery, previous designs of which were described at the conventions of 1903 and 1904. Mr. Horace See presented a paper entitled Some Notes on Steam Boiler Troubles. A paper, entitled Notes on the Strength of Water-Tight Bulkheads for Battleships and Cruisers, was read by Mr. H. F. Norton. The author gave a formula and diagram for calculating stiffness. There were also papers on: Scantling Regulation in Yachting, by W. P. Stephens; How a Ninety-Footer Behaves in an Ocean Race, by P. E. Stevenson; Problems in Connection with High Speed Launches by C. H. Crane; Progressive Speed Trials of the Gasoline Launch "Ludo," by G. C. Cook, and Methods of Conducting Speed trials, by Mr. J. J. Woodward, U. S. N.

THE MANHATTAN BRIDGE CONTRACT IS VOID, declares Justice Dowling of the New York State Supreme Court in a decision handed down on Nov. 21. The specification on which the Pennsylvania Steel Co. submitted the lowest bid is declared to be so drawn as to threaten a wasteful expenditure of public money. In particular the clause in the specifications which permits the use of either nickel steel or carbon steel is declared improper, partly because the alternative quantities are not clearly stated, partly because the decision as to which material shall be used is left with the city's engineer, apparently. The Justice says that it is clear that the city seeks to make a wasteful contract based on specifications which are not sufficiently definite to afford an opportunity for fair competitive bidding. Further, the contract is criticised because it gives the engineer of the Department of Bridges power to change the specifications, while, as the justice states, the city charter nowhere gives power to an engineer employee to make a contract for the city. Work on the bridge is now held up, under an injunction, continued by the present decision, restraining the City of New York and the Commissioner of Bridges from awarding the contract.

THE ADVISORY BOARD OF ENGINEERS, according to published statements which are generally accepted in Washington, has failed to agree on the best plan for the Panama Canal, and majority and minority reports will be presented. The majority report, favoring the sea-level plan, is said to be signed by all the foreign members and by Messrs. Burr and Parsons and Gen. Davis, who were members of the Commission of 1904. The lock canal plan would therefore be supported by Gen. Abbot, who was formerly a member of the International Commission created by the New Panama Canal Co., of France; by Alfred Noble, who has served on two previous Isthmian Canal Commissions, and by Messrs. F. P. Stearns, Isham Randolph and Joseph Ripley. The complete reports are not likely to be ready for publication before the end of December.

The bottom width fixed for the canal is said to be 150 ft. An important change on which the Board is said to have agreed is an alteration in the route of the canal near the two terminals. At the Atlantic end the canal is to debouch directly into Limon Bay, cutting off between two and three miles of distance and eliminating the very sharp curve at the entrance of the canal which has hitherto been severely criticised. On the Pacific side a new location will be made for a short distance to protect the canal prism from floods in the Rio Grande. The canal will pass between two hills, Ancon and Sosa, and the tidal lock in the sea-level plan will be located between them. It is said that the estimate of cost for the sea-level canal is $230,000,000 and the time for construction is set at 15 years.

SIX PRIZES have been offered by the King of Italy, open to international competition, in connection with the Milan Exposition of 1906. The approximate amount of the prizes and the subjects of the competition are as follows:

(1) $1,000 for a convenient and simple device to protect workmen in electro-technics from the currents with which they come into contact.

(2) $2,000 for an improvement, a system, or a machine which has real practical value and possesses the property of newness.

(3) $1,000 for an automatic car coupler.

(4) $1,000 for what has been proven by actual use to be the best system for providing pure, healthy milk to thickly populated centers.

(5) $2,000 for the best type of simple dwelling suited to the climate of southern Italy.

(6) $1,000 for motor boats.

Further information, indirectly if not directly, can probably be obtained through Prof. J. H. Gore, George Washington University, Washington, D. C., or L. S. Ware, 54 Rue de la Bienfaisance, Paris, France, Commissioners of the Milan Exposition.

A RECORD RAILWAY RUN was made on the P. Ft. W. & C. division of the Pennsylvania Lines West of Pittsburg on Oct. 24, 1905. A special passenger train westbound to Chicago ran from Crestline, O., to Fort Wayne, Ind., a distance of 131.4 miles, in 101 min. 20 sec., at the rate of 77.8 miles per hour; and from Fort Wayne to Clarke Junction, Ind., 126.0 miles, in 102 min. 30 sec., at the rate of 73.7 miles per hour. Including the stop at Fort Wayne, 3 min. 20 sec., the total distance between Crestline and Clarke Junction, 257.4 miles, was covered in 207 min. 10 sec., at the rate of 74.5 miles per hour. The run is reported in the "Railroad Gazette" as "the best record ever made for so great a distance." The train consisted of four cars, weighing 520,000 lbs., and a locomotive of Atlantic type weighing 320,400 lbs. with tender. The engine has 20½ × 26 in. cylinders, 80-in. driving wheels, and 109,000 lbs. on drivers; it burned bituminous coal. The train was taking a party of railway officials to the Chicago meeting of the American Railway Association.

A VERY LARGE DRY DOCK was opened at Southampton, England, on Oct. 21. It is 875¼ ft. long from sill to dock head, 90 ft. wide at entrance, 125 ft. wide at coping level, and 43 ft. deep from coping to floor. It is owned by the Southwestern Company and was designed by the company's consulting engineer, Mr. W. R. Galbraith. Sir John Aird & Co. were the contractors. The dock has been under construction since 1900. It has been named Trafalgar Dock.

A WRECK IN THE ENGLISH CHANNEL in the night of Nov. 18 to Nov. 19 caused the death of 123 persons, about 100 of whom were passengers. The passenger steamship "Hilda," of the London & Southwestern Ry., bound from Southampton to St. Malo, France, struck on rock reefs at the entrance to the harbor of St. Malo in a heavy snowstorm and gale, and soon broke in two. Only six persons were rescued.

A much smaller sea disaster occurred off the coast of Nova Scotia on Nov. 17. The coal-steamer "Turbin," under charter to the Dominion Coal Co., struck Black Ledge, off Cape Sable, in a heavy gale. None of the crew of about a dozen men was saved.

CROSSINGS OF ELECTRIC AND STEAM RAILWAYS on the trolley system of the United Railways Co. of Baltimore, Md., are being equipped with special overhead construction as a protection against accidents resulting from the trolley leaving the wire while a car is on the crossing. On the crossing and for some 50 or 75 ft. to either side the trolley wire is covered by an inverted metal trough, about 12 ins. in diameter, which is in electrical contact with the trolley wire. If the trolley wheel of a car should slip from the wire, it would be caught in the trough and would continue to supply current to the car. Stopping of cars on crossings will, it is expected, be eliminated by this device.

PLACING TELEPHONE WIRES UNDERGROUND on the lines between important cities appears to be now started in earnest. It is reported that the Bell system telephone wires from New York City to Wilmington, Del., are being placed underground, a total of 75,000 miles of wire, nearly all of which, if weather is favorable, will be in duct by the close of the year. Eight tile ducts each carrying a multiple cable, and several wooden ducts for wires making way connections, are being laid. An expenditure of two to three million dollars is involved.

A NEW CABLE IN THE PACIFIC was laid recently by the Deutsch-Niederländische Telegraphen Gesellschaft. It connects Shanghai, China, with Yap, one of the Caroline Islands, and is now open to traffic.

THE ENGINEER SCHOOL for the instruction of officers and enlisted men at the Washington Barracks under charge of Major Edward Burr has now 56 enlisted men under instruction. The instruction of officers was almost completely suspended for a year and a half, owing to the urgent demand for engineer officers for active duty. This condition has changed, and the school will resume its full work this winter.

THE MICHIGAN AD VALOREM TAX ON RAILWAYS, the result of a legislative act of 1901, which has been under litigation for some time, has now come before the United States Supreme Court on appeal by the railways affected. Twenty-seven appeals, by as many different railways, are before the Court.

THREE 10,000,000-GALLON CENTRIFUGAL PUMPS, driven by vertical cross-compound engines, are to be erected at the Massapequa pumping station of the waterworks of Brooklyn Borough, New York City. The subcontract for this work has been awarded to the Allis-Chalmers Co., of Milwaukee, by Mr. Michael J. Dady, of Brooklyn.

PERSONALS.

Mr. W. A. Doane, M. Am. Soc. C. E., was promoted on Oct. 1 from Division Engineer to Principal Assistant Engineer of the South & Western Ry., with offices at Bristol, Va.-Tenn.

Mr. Frank Zink has been appointed Acting Superintendent Motive Power and Rolling Stock of the Santa Fe Central Ry., with headquarters at Estancia, N. Mex., succeeding Mr. G. H. Shone, resigned.

Mr. W. W. Millar has been appointed Superintendent of the Fort Worth & Denver City Ry., with headquarters at Childress, Tex. He succeeds Mr. Geo. Geiger, who resigned to accept service with another company.

Mr. John Cassan Wait, M. Am. Soc. C. E., will deliver the address at the Founders' Day exercises of the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y. The exercises are to be held on Nov. 30.

Mr. Floyd W. Parsons has resigned his position as Acting Assistant Professor of Mining at the Michigan College of Mines, and has accepted a position as Chief Engineer of The Victor Fuel Co., with offices in Denver, Colo.

Mr. Judson M. Minor has been appointed an assistant in the City Engineering Department of New Haven, Conn. He succeeds Mr. Frederick H. Osborn, who has resigned to accept an appointment with the Consolidated Street Ry. Co.

Mr. Russell L. Huntley has been appointed Acting Chief Engineer of the Union Pacific Ry., with office at Omaha, Neb., succeeding Mr. J. B. Berry, who has resigned to become Chief Engineer of the Chicago, Rock Island & Pacific Ry.

Mr. John T. Simpson, for seven years Chief Engineer of the Hay Foundry & Iron Works, Newark, N. J., has resigned his position with that company to take effect Jan. 1, 1906, and will devote his entire time to the interest of The American Concrete-Steel Co, Prudential Building, Newark, N. J.

Mr. E. F. Brown has been elected President of the Jonesboro, Lake City & Eastern R. R., and the Chickasawba R. R. The other officers elected at the annual meeting, which was held Nov. 14, are as follows: Mr.

J. B. Driver, 1st vice-President; Mr. J. W. Driver, 2d vice-President and General Counsel; Mr. D. F. Brown, Secretary; Mr. W. E. Talley, Treasurer; Mr. A. J. Kerfoot, General Manager.

Major Cassius E. Gillette, Corps of Engineers, U. S. Army, has been appointed Chief Engineer of the Bureau of Filtration of Philadelphia, subject to the approval of the President of the United States and legislation by Congress authorizing him to accept the position. Major Gillette, it will be remembered, was Chairman of the Board of Investigating Engineers, appointed last July to investigate and report upon all matters relating to work on Philadelphia's filtration plant and boulevard system. The report of the board was made public the latter part of October. Major Gillette received a special leave of absence last July from the War Department in order that he could serve on the Board of Investigating Engineers, and there is not much doubt but that the President and Secretary of War will approve of his appointment as Chief of the Filtration Bureau, and will recommend the passage of an act of Congress granting him necessary leave of absence from his ordinary duties. Mr. John W. Hill, M. Am. Soc. C. E., as Chief of the Bureau, received a salary of $17,000.

Obituary.

Isaac W. Townsend, Superintendent of Buildings in Newark, N. J., from 1881 to 1892, died Nov. 15 in that city, aged 69 years.

William Parkinson, formerly a mechanical engineer in the employ of Thomas A. Edison, died Nov. 20 at his home in Orange, N. J.

Donald MacGregor, an architect with offices in New York city, died Nov. 8 at Bronxville, N. Y., his death following an operation for appendicitis.

Henry B. Hanson, a railway contractor, who had been identified with the building of railroads in the South and with coal mines in the West, died Nov. 19 at Saratoga, N. Y., aged 78.

Albert J. Pitkin, President of the American Locomotive Co., died Nov. 16 at his home in New York city, aged 51 years. A fuller notice concerning Mr. Pitkin is given elsewhere in this issue.

Professor John L. Morris, until recently head of the Mechanical Arts Department of Sibley College, Cornell University, died Nov. 19, at his home in Ithaca, N. Y.; from a paralytic stroke complicated with pneumonia. He was 73 years old and had been head of his department for 36 years.

Frederick H. Betts, an authority on patent law, died Nov. 10 at his home in New York City, aged 62 years. He had been counsel in many cases for the Western Union Telegraph Co., American Bell Telephone Co., Edison Electric Light Co., General Electric Co., Westinghouse Electric and Westinghouse Air Brake Companies, and the Marconi wireless systems in England and the United States. He was also patent counsel to the city of New York.

Robert Whitehead, the inventor of the self-propelled torpedo that bears his name, died at London, England, Nov. 14. Robert Whitehead was born in England. While he was an engineer, acting as superintendent of the Austrian Government works at Fiume, he became interested in a scheme of an Austrian officer, Capt. Lupius, to develop a self-propelled torpedo. The Austrian was the originator of the idea, but he produced no results until he became associated with Mr. Whitehead. The Austrian navy adopted the torpedo in 1868 and now all the navies of the world, including the American, are using it or some form of torpedo resembling it. Mr. Whitehead made a fortune from his invention.

Justin Burns, Assoc. M. Am. Soc. C. E., died Nov. 14 at his home in Watertown, N. Y., after a short illness of typhoid fever. He was born in Watertown in 1870 and was graduated from the Civil Engineering Department of Cornell University in 1892. His first position was with the Third Avenue Cable Ry., of New York city, and later he was with the Detroit, Lansing & Northern R. R., remaining with this road until 1897, when, as the result of a civil service examination, he was appointed Assistant Chief Engineer of Bridges in Bronx Borough, City of New York. During the Spanish War he enlisted in Company M, First Regiment of Volunteer Engineers, and at the completion of his military services he secured a position on the construction of the New York Subway, having charge of the first section from City Hall to Canal St. Later he was one of the Assistant Chief Engineers on the construction of the railroad from Canton to Hankow, China, and after remaining in that country for a year and a half he returned to this country. He was next employed in Memphis, Tenn., as Engineer-in-Charge of the reconstruction of the street railways of that city. His last position was that of Resident Engineer of the Rapid Transit Subway Construction Co., of New York City.

Charles Brown, one of the most notable of the older generation of Europe's mechanical engineers, died at Basel, Switzerland, on Oct. 6, 1905, at the age of 78. He was born at Oxbridge, London, and received his engineering training at Woolwich and in the shops of Maudslay Sons & Field, in which latter he had special opportunity for becoming familiar with marine engine work. In 1851 he went to Sulzer Bros., of Winterthur, Switzerland, where he then remained for 20 years. At the Sulzer works he was intimately connected with initiating and developing their manufacture of steam engines. The poppet-valve steam distribution which since has become virtually standard in Europe was due to Brown. In 1871 Brown took the management of the newly established Schweizerische Lokomotiv und Maschinen Fabrik of Winterthur, which subsequently contributed many advances to locomotive construction. In the early 80's he joined the Oerlikon Maschinenfabrik, where he organized the electrical department, and a few years later he took the management of a marine engine works near Naples, Italy, for Armstrong, Mitchell & Co., of Newcastle. After but a short activity there he took up private engineering practice, first in Naples and since 1891 at Basel, where he died. His career may be summarized by saying that he as much as any other one man may be called the founder of the Swiss machine-building industry. Two sons, who inherited the father's abilities, founded the firm of Brown, Boveri & Co., which they have brought to the first rank among European machine and electric construction works.

William B. Bogardus, whose death was mentioned in our last week's issue, was born in Chicago, Ill., in 1873. A year later his parents removed to Buffalo, N. Y., where his preparatory education was acquired. He was graduated from the Mechanical Engineering Department of Sibley College, Cornell University, in 1896. Upon leaving college he entered the cement business, and step by step advanced until he had become a master in his chosen specialty. He designed many of the cement mills of this country and Canada, and many of the improvements in the cement industry are due to him. Though he had designed a number of plants before this, his most important work was done after he had founded the Peninsular Engineering & Construction Co., of Jackson, Mich., of which he was President and Chief Engineer. Included among these later plants are those of the National Portland Cement Co., at Durham, Ont.; The Peninsular Portland Cement Co., at Jackson, Mich.; The Southern States Portland Cement Co., at Atlanta, Ga., and the Western States Portland Cement Co., at Independence, Kan. All of the above were designed and built in the last five years and aggregate in cost about $5,000,000. Besides being employed by the above named companies to design their plants, Mr. Bogardus was consulting engineer for other cement plants, crushing plants and other manufacturing industries. Mr. Bogardus was prominent in many social and fraternal organizations, as he was of an affable and kindly nature, loyal in friendship, faithful to duty and diligent to the extreme. Among these organizations are Kappa Sigma Fraternity of Cornell University, American Society of Mechanical Engineers and Perseverance Lodge F. & A. M., of Sandusky, O. To his great ability as an engineer and student he added a model character and his untimely death cuts off in his youth a man who was fitted by nature and training to make a remarkable impression on the time in which he lived.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 4 and 5. Annual meeting at New York, N. Y. Secy., W. H. Ross, 258 Broadway, New York, N. Y.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 5-8. Annual meeting at New York, N. Y. Secy., F. R. Hutton, 12 West 31st St., New York.

AMERICAN ECONOMIC ASSOCIATION.
Dec. 27 to 29. Annual meeting at Baltimore, Md. Secy., F. A. Fetter, Ithaca, N. Y.

MICHIGAN ENGINEERING SOCIETY.
Jan. 9, 10, 1906. Annual convention at Lansing, Mich. Secy., F. Hodgman, Climax, Mich.

NATIONAL ASSOCIATION OF CEMENT USERS.
Jan. 9 to 12, 1906. Annual convention at Milwaukee, Wis. Secy., C. C. Brown, Commercial Club Bldg., Indianapolis, Ind.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Jan. 10. Annual meeting. Secy., Willard Kent, Narragansett Pier, R. I.

INDIANA ENGINEERING SOCIETY.
Jan. 12, 13, 14. Annual meeting at Indianapolis, Ind. Secy., C. C. Brown, Commercial Club Building, Indianapolis, Ind.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 17, 18, 19. Annual meeting at Rockford, Ill. Secy., E. E. R. Tratman, 1636 Monadnock Block, Chicago.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 21. Annual meeting at South Bethlehem, Pa. Secy., R. W. Raymond, 99 John St., New York, N. Y

INTERNATIONAL TRAMWAYS AND LIGHT RAILWAYS UNION.—The next biennial meeting will be held at Milan, Italy, in September, 1906; this place was selected on account of the international exhibition which is to be held there next year.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—At the next meeting of the society (Nov. 21, 410 Penn Ave., Pittsburg, Pa.) a paper on "Producer Gas and Gas Producers" will be presented by Mr. S. S. Wyer. The Structural Section will meet on the evening of Nov. 28. Mr. F. W. Patterson will read a paper entitled "Conditions Governing County Road Construction." The Mechanical Section will meet on the evening of Dec. 5. Mr. C. E. Watts will read a paper entitled "Economy in Fuel at Bituminous Coal Mines." Secy., F. V. McMullin.

AMERICAN ECONOMIC ASSOCIATION.—The American Economic Association meets at Baltimore, Md., in connection with the American Political Science Association, under the auspices of the Johns Hopkins University. The first session is to be at 10 a. m. Wednesday, Dec. 27, the last at the same hour, Friday, Dec. 29. Papers are scheduled as follows: "The Present State of the Theory of Distribution," by J. H. Hollander, Baltimore, Md.; "The Regulation of Railway Rates," by H. R. Meyer, Chicago, Ill., and B. H. Meyer, Madison, Wis.; "The Case For and Against Municipal Ownership," by Frederick C. Howe, Cleveland, O., and Winthrop M. Daniels, Princeton, N. J.; "A Quantitative Study of the Labor Movement," by H. W. Farnham, New Haven, Conn.; "Violence in Strikes," by T. S. Adams, Madison, Wis.; "The Economic Future of the Negro," papers by W. E. B. Dubois, Atlanta, Ga.; A. H. Stone, Washington, D. C.; and R. C. Bruce, Tuskegee, Ala. The Presidential Address, by Prof. F. W. Taussig, of Cambridge, Mass., will deal with "The Love of Wealth and the Public Service." Fuller information may be obtained from the secretary, Prof. F. A. Fetter, Ithaca, N. Y.

TECHNOLOGY CLUB OF SYRACUSE.—The second annual banquet of the Technology Club of Syracuse, held at the Vanderbilt Hotel on the evening of Nov. 16, was of more than ordinary interest on account of remarks made by invited guests and members of the Club prominent in the engineering and educational world. Professor John E. Sweet made public his plans for a school of trades, which it is proposed to establish in the city of Syracuse as soon as sufficient money has been raised. Private subscriptions already amount to $20,000. It is wished to obtain $25,000 to equip the shops and begin work. In addition it is desired to maintain a reserve fund of at least $25,000.

Professor Sweet said that the apprentice system is a relic of the past, and that some other method must now be originated for training young men who expect to become expert mechanics. At the present time, in and about Syracuse, it is almost impossible to obtain properly equipped artisans for the large industries that are found here, and that are growing at an unprecedented rate. Professor Sweet stated that he has studied the subject of shop apprentices for more than twenty years, and that his present plans are the culmination of his ideas in this direction.

Professor Albert W. Smith, Director of Sibley College, Cornell University, then said: "At Sibley College we are trying to get closer to practice. I believe the spirit of practice can be introduced into a technical school. In the early days the engineers were taught by men who were essentially mathematicians. We have come to realize the practical factors which cannot be determined except by the judgment of man. The men who teach the young engineers should be men who have had practical experience. Nearly all of the teachers in Sibley College have had this practical experience. Ever so often the teachers are urged to leave the University and take positions where they have practical work to do. I believe every man should be taught to use his hands whether he has to make his living that way or not. I was formerly a student under your Professor Sweet and I have a picture of him on the bench surrounded by a lot of boys eagerly drinking in knowledge from him. When I went out of college in 1878 it used to be the custom for a graduate to conceal the fact that he had been at a technical school as manufacturers did not want to give positions to young men who had been at a technical college. Last spring fifteen to twenty prominent manufacturers came to Cornell to talk with the young men who were about to graduate and nearly every man of the class who wished a position had one before he graduated."

Mr. Edward N. Trump, Director of the Solvay Process Co., spoke on "The Relation of German Technical Education to the Improvement in German Industries." Mr. Trump has recently returned from a trip to Europe, which has occupied several months. During his absence abroad he made a special study of German education, and spoke very highly of the advantage of military discipline in the training of young engineers. He believes that the young German boys leave school much better equipped than American boys.

Mr. William Kent, Dean of the Smith College of Applied Science, Syracuse University, spoke of the growth of the manual training and of the trade school movements during the past twenty-five or thirty years, and said that he heartily endorses the tendency of modern technical education toward practice and hand work.

The Syracuse enterprise is to be termed "The Artisan School." Professor Sweet is so well known in the engineering profession and has so many friends that the financial backing is sure to be obtained. Secy., W. M. Booth.